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SKETCHES OF THE GREAT EXHIBITION.

AMERICAN THREAD LACE.

It is taught in our schools that fine lace is made in Europe, and that it was first designed and made by a Belgian woman, as a means of obtaining a livelihood. It is also said that after the business had been, for many years, principally in the hands of the large capitalist and manufacturer, some of the wealthy ladies of Brussels and Paris have, within a few years, succeeded in effecting a revival of the art, as such, in the boudoir and parlor of the private family.

But few who come here are prepared to see such a display of *American-made thread lace* as is shown in the Women's Pavilion. And the specimens are from various makers, located at points widely distant from each other. Among others may be noticed Mrs. Rachel Stansbury, of 241 Fifth street, Jersey City, who shows the finished lace and also the common form of lap cushion used in making it. This cushion is about twelve or fourteen inches across, round, with a flat wooden bottom, the top being a firm cushion about three inches deep, upon the cover of which the pattern intended to be made is first marked out. This cushion being in the lap of the weaver, she puts certain pins into the pattern, to guide and assist her in forming the work, and taking a number of little spools of thread, she interlaces them with each other and around the pins with great rapidity. Starting upon the outer edge of the cushion, she works towards herself, moving the pins forward as the work progresses, until it gets inconveniently near her, when she "fleets" the whole back to the outer edge of the cushion, and repeats the operation.

Here are also samples and card of the "Misses Skuse, designers and manufacturers of Irish point lace, at 269 Shawmut avenue, Boston." This smacks of business, and gives the impression that making lace by hand is not merely a ladies' amusement on this continent.

Fine work is shown by the Sisters of St. Joseph's, of San Augustine, Florida; and the sample of Spanish work (a cushion cover) by Miss Sofia Bravo, of the same place, is curious and rich.

In the accompanying sketch is shown the cushion exhibited here, with specimens of her skill, by Josepha Eck, of 1134 Washington avenue, St. Louis, Mo. The sketch shows the position and manner of handling the spools. It will be noticed that this cushion is made round, or properly speaking cylindrical, resting upon a neat wooden trestle of small size. The pattern may be worked continuously, and by turning the cushion as the work progresses, the position of the pins is at all times kept the same as regards the worker.

From the ease and latitude in posture it allows, as it can be used either sitting or standing, this appears to have some advantages over the flat cushions; while, from its smaller size, it can be carried in a reticule when spending the day with a friend. But Miss Eck is not limited to a mere ornamental exhibit, but offers to give lessons in the art, and claims to be the first professional teacher in her line in this country, as she naively informs us she "has already taught hundreds, and is ready to teach thousands more." She also says that "the art is easily learned, yet pays better than any other ladies' handiwork."

The cushion used by Ada Sophia Andersen, of Sweden, who is practising the art in the Women's Pavilion, is a combination of both of those described, and the rapidity with which she handles the spools resembles a skillful piano-player running over the scales.

If, as stated, two or three millions of dollars are sent abroad annually to pay for imported laces, it certainly appears to be a matter of public interest that the art should be fostered here. And on this point it is to be observed that the Belgian and French laces exhibited here claim to have a value in the aggregate of over two hundred thousand dollars—or as they express it, a million francs—and include laces valued from twelve hundred to four dollars per yard, shawls from fourteen hundred to sixty dollars each, dresses from seven thousand to twelve hundred dollars apiece, handkerchiefs from five hundred to eighty dollars, etc.

There is, certainly, no more valued or characteristic heirloom than the specimen of the artistic skill and taste of the ladies of a family; and while the spinning and weaving, upon which our grandmothers prided themselves, are swallowed up by the big factories, while even the more varied art of embroidery is turned over to the sewing-machine, there was little prospect that the next generation would give the ladies of the present time credit for knowing how to do anything but talk politics or scandal, until this revival of the fashion of making their own lace opened an opportunity for woman to retrieve her credit, and leave her children something beautiful, and that will wear, of undoubted quality, and always in fashion. How many of our Western belles would gladly be married in a lace dress valued at twelve or fifteen hundred dollars or more, if she could accomplish it by the expenditure of a year or more of her leisure and spare moments? And here it is well to draw the line between the pride and vanity of laziness, that fattens upon the labor of others, whether a wealthy father or a poor seamstress; and the feeling for the beautiful, taste, patience, perseverance, judgment, skill, and other good wifely qualities shown by beautiful decorations of this class, designed and made by the wearer.

The birds plume their feathers, laying them with care; but even the proverbial lazy-bird employs no professional hairdresser. The true taste is shown by the lady who adorns her breakfast table with flowers of her own raising.

TATTING.

Nearly allied to the above is the art of making tatting, but as this has been practised in this country for many years, it is less surprising to see it well illustrated here. Still, some of the specimens shown cause exclamations of surprise and admiration, even from ladies who have made it all their lives. Among the finest and richest is a handkerchief, the border being about three inches wide, worked of tatting exceedingly rich and fine in design, the number of the thread being 100. It is not to be wondered at that it took the lady, Mrs. J. L. Oster, of Philadelphia, three months of leisure and spare time to complete it. Another sample is a small tidy, by Miss Daisie Cheeney, of East Greenwich, Rhode Island (who solicits orders). The design is beautiful, and attracts great attention and commendation. Some fine specimens of guipure, and all of the variations down through crochet and knitting, show evidence of great artistic feeling, and this, when joined to patience and judgment in choice of materials, always produces work of value.

A. V

THE INTERNATIONAL EXHIBITION OF 1876.—THREAD-LACE MAKING.

THE WOMEN'S BUILDING.

INVENTIONS AND FOREIGN EXHIBITS.

In section D of the Women's Building is a small tank of water in which are floating models of the life-preserving mattress invented by Mrs. R. Mountain, of New York. Any one who remembers the awful and, as it seemed, needless loss of life in the wreck of the "Atlantic" years ago, and similar disasters since, must be interested in any plan that looks practicable for saving women and children. This is close at hand, being used as the ordinary berth mattress, and is reversible, so as to make no difference which side is up when thrown into the water; thus providing for the senseless and frantic haste of people in terror of drowning.

This invention has been officially approved by the Board of United States Supervising Inspectors of Steamboats, and adopted for use as an auxiliary life-saving appliance, in lieu of boats or rafts, an allowance being made of two persons to each mattress.

In the same humanitarian line is a horse-protector, invented by Mrs. Sarah Ruth, of Philadelphia. Imagine a horse-blanket, lifted slightly from the body by a slender wire frame, extending over the head, and you see the unspeakable relief the contrivance would be during the summer heat. There is a fabric of cork-shavings, which would be superior to blanket for this purpose, being light, and a non-conductor. Mr. Bergh, still devoting his life to the prevention of cruelty to animals, will lose no time, it is to be hoped, in making a full and fair trial of this protector, in mercy to the poor horses.

"Let me show you," said the lady who had called my attention to the horse-protector, "something much more attractive to the crowd than any humane invention. To one person who cares for the dumb creature, ten, twenty, have I seen flocking over to this paper-cutting stand. Not but that it's very beautiful, and very curious." It certainly was. We stood and watched the nimble scissors deftly, swiftly cutting figures, flowers, leaves, out of white paper, which, placed on a black ground, revealed the utmost accuracy and grace of delineation. It is a gift of nature; the artist has practised from a child, and is a genius in her way, like Paul Konewka.

Mrs. Temperance P. Edson, Mass., exhibits an India-rubber life-preserver, self-inflating, and adjusted in half a minute.

Another dish-washer, made of galvanized wire, is invented by Mrs. Charlotte H. Sterling, Ohio; and a dust-catcher by Elizabeth M. Page. This last is a large pan on rollers, into which the house-maid sweeps—a great comfort if it answers its purpose, and I do not see why it should not.

A neat little tin lunch-box, with divisions inside, heated by a spirit-lamp beneath, is patented by Mrs. M. Bradley, New York; and a gridiron for beefsteak, with receptacle for gravy, by Mrs. Ann L. H. Grahame, Pennsylvania. Also a magic rolling-pin, made of tin, holding various conveniences inside, by Mrs. D. Grace Hunkins, of the same State. Mrs. A. S. Sherwood's fountain griddle-greaser and scraper looks ready to make easy work of baking hot cakes.

Here, on the wall, hangs a map of Coston's telegraphic night signals. Mrs. Fergus, physician and medical electrician, appears to use the same curative agents as Mrs. French, who exhibits in this neighborhood a glass case full of patent electro-magnetic appliances for the human body, supporters, belts, bands, lung protectors, etc. Both are Philadelphia physicians.

In this connection, prevention being better than cure, the improved underclothing for women and children, invented by Mrs. O. P. Flint, of Boston, is worthy of attentive consideration. Doctors may think they know, but only those of our own sex really do know, the amount of harm done by a few mistakes in the underwear of women, especially in the weight of dragging skirts. There seems a kind of superstition about it. The same persons who, as children, avail themselves of buttons and other masculine comforts, appear to feel it a matter of feminine propriety, on arriving at womanhood, to have their clothing made in the old, uncomfortable way, which is a daily and hourly injury to health.

There is no sacrifice of fashionable appearance involved in the modern improvements, as will be seen by examining Mrs. Flint's models. The perfect weather-protector, made of gossamer rubber-cloth, is a long step in advance of the heavy, insufficient water-proof; and the skirt with eight pockets looks desirable.

Interesting to mothers is Madame Harmon's doll's chart for children's use, a *fac-simile* of the large one. Little girls, by observing the directions, can become familiar with the process of cutting and fitting, about which so many, who would gladly do their own dress-making, feel an awkward incompetence. It looks like something to be commended to the Kindergarten, the training of the faculties in this way.

An American sewing-machine was run by an operator, who explained the specialty that it claims—a contrivance to avoid the threading of the needle, so trying to the eyes on a dark day. The process can almost be gone through without looking at it. Adjoining is a case of machine-worked articles of very elaborate and elegant make.

A model for cemetery lots, with ornamented recessed rail, for the growth of flowers, is shown by Mrs. E. M. Stigale, Philadelphia, sole inventor and patentee; and a combined travelling-bag and chair, by C. Lammonier, New York City; a mathematical measurement system of dress and garment-cutting, invented by Miss L. E. Robbins, is stated to be taught with great success in the public schools of Boston.

Miss E. Keyser and Mrs. M. A. Jones, Philadelphia, exhibit models of trimmed dresses and specimens of hand embroidery; E. J. States, of Boston, ladies' and children's outfits; Mrs. S. E. Anthony, Smyrna, Del., a framed specimen of zephyr work—flags and emblems of various countries; Miss Susie Barton, Maryland, an oriental scene in tapestry painting; and another painting of the same kind is shown by Miss Melanie Henbel, Philadelphia.

From Worcester, Mass., comes some fine needle-work and darning on net, by a lady 80 years old; and mittens and stockings knit by Mrs. Abigail Flagg Lovering, at the age of 100 years and four months, with a photograph of the ancient dame; also from Worcester, a screen on which a branch of apple blossoms, with a tuft of narcissus beneath, are painted in oil on a ground of sage-green silk, so artistically that you half fancy the fragrance that alone is lacking to complete them.

On the south wall are hung hand-made rugs, designed and worked by Mrs. E. B. Shapleigh, Philadelphia; materials, burlap and carpet thrums or waste; and there is a child's creeping-rug, of unique design, covered with figures, ornamental and grotesque, of animals, children, trees, alphabetical letters, cut out of colored cloth, and sewed upon black cloth, made by Miss Edith Beach, Connecticut.

Miss Lizzie Todd, Columbus, Ohio, exhibits rich silk embroidery on cashmere; and there is white embroidery by Mrs. E. G. Whitesides, Germantown; marking in indelible ink is shown by Mrs. R. Bancroft, Wilmington, Del., and Miss M. A. Torrey, Elizabeth J. West, and Emily B. Phillips, of Philadelphia.

A tapestry picture on the east wall represents the marriage in Cana of Galilee; another, of Abraham and Hagar, is by Miss Lina Fieldner, of Wisconsin; and another, of Washington standing beside his horse, by Miss J. Whittemore, of Charleston, S.C. Still another, the largest and most ambitious of all, is the battle of Langside, and death of Douglas in defence of Mary Queen of Scots. There is an extraordinary quantity of this needle-work painting. Why any mortal, even if she be feminine, should deliberately choose the troublesome and cumbrous material of worsted or silk, when she might use brush and color, is hard to understand.

A glass case of exhibits from Providence, R.I., contains silk embroidery, by Miss Victoria E. Walker, which some ladies passing by pronounced superb; a child's carriage robe, from Employment Society; affghans, by Mrs. Henry Cogden; sofa cushion, by Fanny L. Brown; and from the Convent of the Sacred Heart, zephyr-knit shawls, and pocket-handkerchiefs exquisitely worked.

Specimens of fine needlework and silk embroidery, from the Union Benevolent Association, Philadelphia, fill a large glass case. Some work of the same kind comes from Baltimore; among the articles, an apron done by an old lady of seventy-five. A white silk flag is elegantly worked with the national emblems, by Mrs. C. Hewitt Pfordt, Albany, N.Y. A curiosity is a framed specimen of needle-drawing—a portrait on white silk with fine black silk, executed by Mary S. Riley, Kentucky, which is a remarkable performance, especially the shading on the face.

Madame Brosse, of Philadelphia, exhibits models for fitting ladies' dresses by self-measurement, for which she can show a silver medal awarded her at the State fair of California in 1872.

Some perspective outline models of wire, for facilitating drawing in schools, are desirable things if found by trial to answer their purpose. Facilities for drawing in perspective are needed.

Miss Donaldson, of Baltimore, sends two beautiful decorated panels—cloth-of-gold roses, proclaiming their name in richest coloring, and a charming handful of blossoms from the woods—cardinal-flower, pipsissewa (admirably true to nature), sunflower, blue lobelia, and a lovely white feathery spire, all intermingled with fern-sprays. Miss Nicholson, of the same city, sends a painted panel, a blue-jay on a branch of gum-tree.

FOREIGN EXHIBITS.

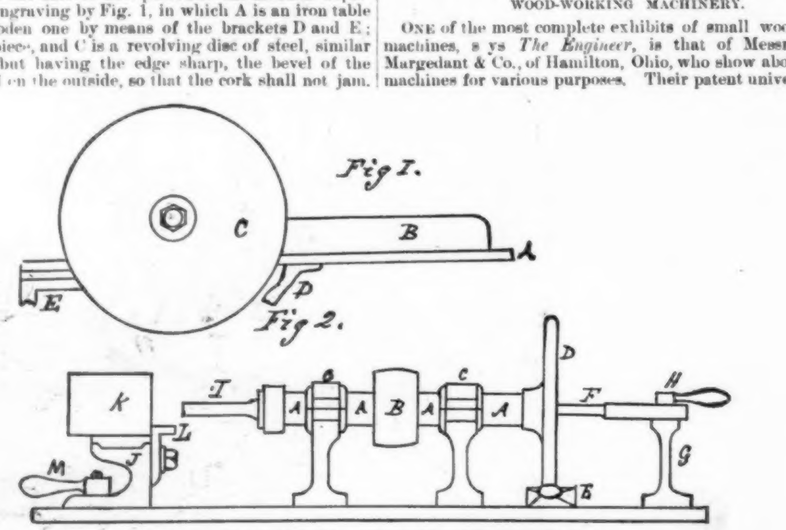
From England we have needlework by some of the royal family; embroidery by the Princess Beatrice, and a larger piece of work by the Princesses Alice and Helena. With these is a fine napkin, the flax spun by Queen Victoria.

Flax-thread pillow-lace, made by cottagers in Buckinghamshire, is exhibited by Miss Lucy Marion Hubbard.—*New Century for Woman.*

MACHINERY HALL.

CORK MAKING.

THE cork-making machines exhibited by Armstrong, Brother & Co., of Pittsburg, are kept in continuous operation. The cork from the bale is first passed to the machine represented in our engraving by Fig. 1, in which A is an iron table bolted to a wooden one by means of the brackets D and E; B is a guide-piece, and C is a revolving disc of steel, similar to a circular, but having the edge sharp, the bevel of the blade being all on the outside, so that the cork shall not jam.



CORK MACHINES AT THE EXHIBITION.

The pieces of cork from the bale are laid upon the table A, and kept against the guide or gauge B, whose distance from the knife regulates the width of the strips the cork is cut into. The cork strips next pass to the machine shown in Fig. 2, in which A A A A represent a revolving spindle, driven by the pulley B, and fitting easily, and capable of being slid or moved horizontally back and forth through the bearings provided in the standards C C. Upon one end of A is the flange D, which passes down into a recess provided in the lever E, so that if the lever E is operated laterally the spindle A A A A will also be operated laterally. I is the cutter, which is formed of a hollow piece of cast-steel tube, parallel in its bore, and with a sharp edge produced by bevelling off the outside. F represents a round spindle, which passes through the revolving spindle A A A A, the latter being made hollow to receive the former. The spindle F protrudes into and nearly through the cutter I. It is supported and regulated in its distance up the spindle A A A A by the hand-screw H, which screws it to the face of the bracket G, that end of the spindle F being flat and provided with a long slot. J is a tail-stock or back-head, adjustable by the screw handle M, the upper part of J being a block of hard wood denoted in the drawing by K. The gauge L is adjustable by a nut as shown. The operator places a strip of cork on the gauge L, and while the machine is running at a high speed he pulls towards him the handle E, thus forcing the cutter through the cork and up against the wood block K. He then moves the handle E back again, which withdraws the cutter, carrying the cut cork in the bore of the cutter until the cork meets the end of the stationary spindle F, which retains it, and the cutter passing back leaves the cork, which falls down. After the machine is once set, therefore, the operator has nothing to do but to feed the cork strips with one hand, and operate back and forth the handle E with the other hand.

To taper the corks, they are fed by hand in a horizontal position down an inclined trough to a vertically-operated plunger having its upper end hollowed to receive a cork, which drops into this hollow when the plunger is at the bottom of its stroke. It is then carried up by the plunger and held for an instant horizontally level with a rapidly revolving spindle similar to a lathe spindle, but having a flat and solid end, then a stationary spindle, answering to the dead centre of a lathe, approaches and forces the end of the cork against the revolving spindle, which by friction revolves the cork. At the back of the position now held by the revolving cork, and lying in a plane inclined to the plane of the length of the cork, is a large revolving steel disc, similar in form to that shown in Fig. 1 at C. This steel blade, while revolving at a high speed, is traversed over the top of the revolving cork, cutting it taper and of the necessary diameter from end to end at one cut. As soon as the cork is thus turned, which takes but a second, the driving mandril recedes and releases it, the plunger falls, carrying the cork with it, and while the cork falls below the machine the cork cuttings are carried by the revolving cutter to the back of the machine, as follows: from where the cutting operation is performed for about one third of the circumference of the disc-knife it is provided with a guard, which retains the cuttings upon the knife, but on leaving the guard the centrifugal force throws the cuttings off and into a box provided to receive them. The capacity of each of these machines is about 250 gross per day.

Power, Taintor & Co., of Philadelphia, exhibit a double-surfacing endless-bed planer for wood. In this machine the position of the knives for both the top and bottom surfacing is stationary. The pressure bars on each side of the lower surface are adjustable in their height, thus regulating the amount of the cut to be taken off by the lower surfacer. Above the lower surfacers is a movable pressure bar, which acts to keep the work to the table by being heavily weighted. The upper surfacers are adjustable in their amount of cut by the highering or lowering of the bed, which is done by power by a combination of four screws, operated by suitable bevel gearing; the whole bed is an endless chain formed of flat bars of iron, carried in a substantial and firm frame. The machine will take in stuff 28 in. wide and from $\frac{1}{2}$ to 12 in. thick. The rate of feed is 60 feet per minute. The knives are $5\frac{1}{4}$ inches in diameter and make 4000 revolutions per minute, the feed being thrown on or off by an ordinary belt tightener. The loose pulleys of this machine are quite novel in their construction, inasmuch as the main part of the face, upon which the belt is intended to run when the machine is standing still, is made 2 inches smaller than the diameter of the driving-pulley, the object being to relieve the belt of tension when the machine is not at work. To enable the belt to pass to the tight from the loose pulley the latter is provided with a cone or taper part, running from the reduced diameter of its face to a diameter equal to that of the driving pulley. This arrangement will probably answer well enough, providing that the edge of the belt is kept, when on the loose pulley, well clear of the tapered flange, which would operate to stretch that edge and side of the belt.

ILLUSTRATIONS OF THE EXHIBITION.

WOOD-WORKING MACHINERY.

ONE of the most complete exhibits of small wood-working machines, says *The Engineer*, is that of Messrs. Bentel, Margedant & Co., of Hamilton, Ohio, who show about a dozen machines for various purposes. Their patent universal wood-worker will execute almost every description of jointing, squaring, planing, rabetting, etc., and is fitted with a neat arrangement for adjusting the level of the tables by means of wedge-shaped slides, and has the important advantage of allowing two workmen to be executing different jobs at the same time.

PRINTING PRESS.

Messrs. J. W. Daughaday & Co. make the "Model Press," which is extremely well adapted for what may be called amateur printing, or for printing circulars, cards, etc., by business houses. The smallest size measures 5 in by $7\frac{1}{2}$ in. inside of chase, and the largest, with a self-inking arrangement, 6 in. by 9 in. The bed A of the "Model Press" is stationary, and is slightly inclined toward the platen B. The bed and frame are cast in one piece, giving the press great solidity, so that there is no chance for a "slur" of the form during the impression. The chase C, which holds the type or form to be printed, fits into slots made to receive it at the lower side, while the top is secured in such a manner that fixes it to the face of the bed as rigidly as if it were one piece with it; yet it is so constructed that it can be removed in an instant. On the back of the platen, next the operator, are four screws which act on the face of the platen and *regulate* the impression. These screws are turned with a strong key-wrench which accompanies the press, and when not in use it can be carried in the pocket. The same wrench also fits the screws in the chase, which are used to tighten the form therein. These screws entirely do away with the old and clumsy method of "locking up" the form with a mallet and wedges, or "quoins." I is the inking disc, which revolves slightly with each impression by a simple pawl-and-ratchet arrangement underneath, and not shown in the engraving. A bracket on the rear of the press supports the roller-arms J, which are accurately balanced by the balls K; these arms carry the rollers L L from the distribution disc over the face of the type and back to the disc again, giving a perfect distribution of the ink with each impression. The motion is given to the arms carrying the inking rollers direct from the platen by the curved arms or pitmans M. The grippers O are operated by the rod N, and act upon the torsion principle; hence, can never become weak or get out of order. They can be adjusted to any desired width of form, and can be secured in an instant. The power is applied in such a manner that there is no "lost motion" or increased force required to operate the self-inking attachment. At the instant when the whole power of the press is needed for making the impression on the face of the type, the inking apparatus has finished its work and remains stationary until the impression is over. Then the surplus power is used for inking the form for a new impression.

PORTABLE DRILLING MACHINE.

The portable drilling machines by Messrs. Thorne, De Haven & Co., of Philadelphia, are exceedingly well worthy of notice. The object of these machines is to enable the drill to be taken to the article to be drilled, and being there driven by power, and thus obviating the use of the hand ratchet brace, or of conveying a heavy forging or casting to a fixed drilling machine. The operation of the machine is as follows: The counter hanger is bolted to the ceiling or other convenient place, and receives power from the "line shaft" by a flat belt on the fast and loose pulleys. The frame carrying the "idlers" rotates on a hollow stud, through which the round belt or rope passes to the grooved driving pulley. The rotation of this frame permits the belt to be led to the drilling machine in any direction, radially, from the hanger, while the rise and fall of the weighted "idler" permits it to be led to any point within the scope of this rise and fall—say, ten to fifteen feet or more. By inserting sections of belt, by means of the hook couplings, any distance can be reached. The base of the drilling machine is intended to be bolted or clamped to the piece to be drilled. The height of the post can be adjusted to suit the different lengths of drills and chucks used in the spindle. The radial slotted arm is fastened to the post by the stud and nut; the position of the drill being adjusted by the screw which travels the arm, and the worm and tangent wheel which rotates it on the post. When it is required to drill parallel with the base, the post is held by the clamp bearing on the side of the base. There is a shoulder turned on the bottom of the ball on the gear frame, and a half collar fitted to it and bolted on the arm; this keeps the spindle square with the base. When this half collar is removed, the spindle can be set to an angle in any direction.

PUNCHING PRESS.

A. H. Merriman's patent power punching press is fitted with an adjustment which is rather novel. This adjustment, whose parts are represented on the right of cut, is all made of steel. No. 1 goes on the wrist; No. 5, with a knuckle joint on one end, is attached to the slide or gate. No. 3 is a central sleeve which Nos. 1 and 5 screw into with a right and left hand thread. Nos. 2 and 4 are two binding nuts which screw on the outside of the above sleeve on each end. The sleeve is slit into four sections at the ends, and when these binding nuts are screwed on, the outside being tapering, these nuts clasp the whole firmly together. To adjust the punch, the actuating bar is placed in the holes shown in the centre of the sleeve, and by turning the bar either way the punch can be adjusted with the greatest nicety. In setting dies there is no necessity for throwing off the belt or stopping the balance wheel. By applying a wrench to the nut on the front end of the shaft, the slide and punch can be moved up or down. The lower end of the pitman is hinged immediately over the punch shank, and when at work the position of the pitman is nearly on a direct line with the motion of the punch, thus exerting all its force upon the work. The head of the press is bored out the whole length, thus avoiding the liability of sand getting into the joints, and giving a long bearing surface to the s'a't. By the arrangement of the clutch at the back of the press the wheel is always running, but the die is only moved when the treadle is depressed; by this contrivance fast and loose pulleys are dispensed with, and the momentum of the heavy fly-wheel is not checked.

BRAYTON'S HYDROCARBON ENGINE.

This novel invention was fully illustrated in the SCIENTIFIC AMERICAN for May 13th, 1876. Mr. Brayton exhibits two engines, one larger than the other. The drawing shows the construction of the smaller engine. A is the working cylinder of the engine, which is jacketed by a water cylinder. B is an air pump actuated by the working cylinder, and employed to compress air into the two reservoirs C C, constituting the base of the frame. D is a pump, which supplies the petroleum or other suitable fuel, as fast as it is needed for combustion. The other engine is double-acting, and is furnished with a beam, the column carrying the beam centre being employed as the reservoir for water. The air pump is also double-acting, and is placed over the motive or working cylinder; the latter having a diameter of 10 in. and 15 in. stroke. The engine is constructed to stand a pressure of 100 lbs. on the square inch, and to make 200 revolutions per minute. The oil reservoir is formed in the frame supporting the crank shaft; but if the use of a reservoir of oil is objected to, the oil pump can draw its supply through a pipe from an oil tank placed at any convenient distance. This is now being done with the engines exhibited, as the authorities objected to cans of crude petroleum being brought into the building. The great economy of this engine is due to the fact that one volume of crude oil can be burnt with twenty-five volumes of highly compressed air.

STEAM HAMMER.

An extensive exhibit is made by Messrs. Ferris & Miles, of Philadelphia, comprising steam hammers, punching machines, lathes, slotting machines, drills, and lathes for car and locomotive axles. We give a cut of one of their excellent steam hammers.

PAPER-CUTTING MACHINES.

Messrs. Brown & Carver, of Philadelphia, show at the Centennial Exhibition, says *Engineering*, a number of paper and card cutting machines, from which we have selected an illustration. Apart from the general solidity of the design there are several points calling for special notice. The pressing table, which is raised and lowered by the hand-wheel at the top of the machine, slides upon the vertical bar *a* forming part of the frame. The presser itself consists of a number of vertical plates, several inches wide at the bottom, and they hold the paper so that strips only half an inch in width can be secured in the press and cut with facility. In front of the main table, and giving motion to it, is a small wheel divided into sixteenths, and working a screw of such a pitch that one complete turn of the wheel advances the table 1 in.

The knife has a diagonal motion given it by means of the fly-wheel having on one end of its spindle a pinion gearing into a spur-wheel with a slotted centre, in which slides one end of the diagonal connecting-rod attached to the knife. In the machines exhibited a double gear is added, which is easily thrown in and out of operation, and is used when the knife is somewhat dull.

Besides card-cutting and other similar machines, Messrs. Brown & Carver exhibit an ingenious little arrangement for fringing paper. It consists of a cast-iron frame, the top of which forms a table to which are bolted two parallel guides, extending nearly the whole length of the table. The guides are fastened to the latter by bolts passing through slots so that the distance between them may be regulated for different widths of paper. Between these guides runs a band-strap passing over rollers at each end of the table. At one end of the machine is a vertical grooved wheel turned either by hand or power, and giving motion by means of a cord to two small grooved wheels below and on each side of it. These wheels are mounted on the end of spindles extending along the table outside the guides before mentioned, and parallel to them. At the opposite end of each spindle is a disc, carrying one or more knives, which can be shifted in or out by a set screw, according to the width of fringe it is desired to cut. A worm on one of the spindles drives a worm-wheel mounted on the sam shaft as the roller over which that end of the horizontal strap before mentioned passes. By this means the strap is driven forward slowly, and serves as a carrier to the papers placed in the machine to be cut. At the opposite end, and directly opposite the cutter, a roller is placed over the strap, and this serves as a presser to the paper as it passes underneath, when fed forward by the strap. The fineness of the cut can be regulated by altering the feed.

BAYONET POLISHING AT THE EXHIBITION.

AN engraving, on page 531, for which we are indebted to *Frank Leslie's Illustrated Newspaper*, exhibits the mode of polishing bayonets upon emery wheels, as shown practically in the Exhibition by Messrs. E. Remington & Sons, of Ilion, N. Y. Their display of firearms, military equipments, and fine mechanism is very large.

INTERNATIONAL EXHIBITION OF 1876.

No. 22

EXHIBITS OF THE BRIDGEWATER IRON WORKS AND THE RIDER LIFE-RAFT COMPANY.

ON the south aisle of Machinery Hall, near the eastern end of the building, may be found an exhibit by the Bridgewater Iron Company, which, while it is of great interest and importance to the metallurgic industry, is an exceedingly attractive one to the general visitor, from the fact that, considering the materials at hand, the display is not only very ornamental, but really artistic in its way.

This firm claims to be the oldest concern in the iron business in this country, as they are the direct successors to the old works of the Leonard Bros. at Bridgewater, the first manufacturers of iron in the United States.

Mr. Geo. B. Stetson, the president of the company, is entitled to great credit as the designer of the display made by them. The establishment where these goods are produced is now one of the most extensive in the country, employing over 500 men, and notwithstanding that their exhibit is more than ordinarily large and fine, it can give but a faint idea of the extent and capacity of the works. Mr. Stetson has been in active service in this corporation for thirty-one years, and Mr. Nahum Stetson, the present treasurer, for fifty-two years. Some idea of the character and extent of this establishment may be found from the fact that in the past year they have consumed 14,500 tons of coal, 75,000 bushels of charcoal, 10,000 tons of iron, 750 tons of copper, and 300 tons of spelter. The power required is furnished by five steam-engines and eleven water-wheels. Among remarkable pieces of machinery at these works are a boring-mill 20 feet in diameter, weighing 130 tons; a slotting machine with a stroke of 3 feet 6 inches, of 85 tons weight; a double lathe for large steamship shafts, 85 feet between ends; another in which there are 75 tons of cast iron, and a double planer 30 feet square, weighing 35 tons, all of which are among the largest and heaviest machines of the kind in the world. Brass castings have been made here weighing ten tons. The first locomotive crank ever made in America was forged in their smith-shop, as was also the original anchor of the old frigate "Constitution." During the late war, of 160 vessels built by the Navy Department, the forgings for 80 of them were made at this establishment. At the commencement of the late war these works were the only ones in the country capable of making the heavy castings and forgings at that time required in such great quantity. The service rendered by them therefore will be historically remembered in connection therewith, as they have been during the past century for similar services during the War of the Revolution and of 1812.

As this establishment is now constituted, and as indicated by the character of their exhibit, the name of "iron company" is something of a misnomer, as it only partially indicates the character of their productions. One of their principal manufactures at this time is that of seamless brass and copper tubes, and a most elegant display of these goods is made in connection with their other work. These seamless tubes are first cast of the required weight, and after annealing are drawn through dies upon mandrils, being annealed after each drawing. The tubes shown range from $\frac{1}{16}$ to 6 inches diameter, and are artistically arranged in such a way as to simulate, in central perspective, the interior of an apartment. They are shown in lengths up to 25 feet. They also show a large variety of rolled tubes. These latter are cast, annealed, rolled flat, and then opened and finished upon a mandril. Every tube is tested under 400 pounds water and 90 pounds steam pressure to the square inch, and when required is turned inside and out, or inside only, by a process invented by Mr. James Ferguson, the superintendent of the works. The railing surrounding the exhibit is made up of this tubing, in all stages of progress, from the casting to the finished tube, and forms quite an interesting feature in the exhibit. Among the tubes here exhibited is the longest seamless one ever made, being 2 inches in diameter and 25 feet long. This firm also manufacture nails in large variety, and in their exhibit may be seen, in contrast with their present productions in that line, some nails made by James and Henry Leonard, in 1652, in Taunton (now Raynham), Mass. These nails were taken from the historical old Leonard House, which was built previous to 1670. The exhibit also includes small cast-iron paper rolls; copper and brass bars for bolts; a large variety of turned reservoir metal; brass, copper, and iron nails; and among the curiosities is the first piece of iron ever forged at the works, done in 1782.

The history of this pioneer concern forms no insignificant part of that of this country, and would be most instructive and interesting, if not somewhat inappropriate, in this place. It may be said, however, that judging by the very excellent character of the goods exhibited, and the record of these works, no one establishment in the country can lay claim to be more truly representative of American ideas and progress, or more thoroughly identified with its best interests in the way of metallurgic productions.

On the transept, near the Corliss engines, is another very interesting and novel exhibit, and one which should enlist the attention of every one, particularly the traveller; and who in these days does not come under that head? Next to the prevention of the explosion of steam-boilers, nothing has enlisted the efforts of inventors to a greater extent than the means of saving life in cases of shipwreck or fire at sea; and when we remember the very large number of human lives which have been sacrificed in this way since the advent of the steamship, it seems almost a reflection upon the inventive faculty of man that no surer or better means have been provided for the temporary safety of passengers and crew in cases where a vessel has to be abandoned at sea. The apparatus alluded to above, the Rider Life-Saving Raft, seems to meet the requirements of this case most completely, and is at least a most decided advance in this humanitarian specialty. The apparatus is shown in perspective in the figure with the people from a distressed vessel occupying its deck.

Two of these rafts are on exhibition—one in Machinery Hall, elevated so as to permit of an easy examination of every part, and the other afloat on the lake north of the Hall, where it is daily exhibited by Capt. Dunn, an experienced boatman and sailor. This one is fitted with a sail, and is manœuvred, both by it and the oars, very perfectly by the captain, who invites, and always obtains, large parties from the visitors to accompany him on his voyages.

The Rider Life-Raft is composed of two cylinders made of rubber and canvas cloth, which are pointed at either end in some semblance of the bow of the ordinary boat, and inflated by means of bellows to a sufficient internal pressure to resist compression from the action of the waves under the full load put upon them. These cylinders support a deck of white pine, which is held in place by hoops of hickory surrounding the cylinders, of such diameter that when inflated the cylinders fit tightly in them; the ends of the hoops are secured toward the centre of the raft, and at about the centre of the height of the cylinders extend across in parallel pairs encompassing the deck. On the top and bottom of the cylinders and parallel with their axes are placed rails, which are secured to the hoops by metallic stirrups. The upper of these rails serves to support the thwarts or seats which extend across just as in an ordinary boat, as well as the row-locks, and the lower ones act as keels to prevent falling to leeward when sailing on the wind, both acting as girders in stiffening the elastic cylinders. The rails are of spruce, and the whole frame-work is very securely fastened with copper nails and brass fastenings. It is propelled either by sail or oars, with both of which it is fully provided. Around the raft are placed three life-lines for sustaining people while in the water, and six life-line buoys with two small cork buoys on each line; in fact, all the paraphernalia necessary to reach people in the water at a considerable distance from the raft, sustain them until brought to its side, and then lift them aboard, are fully provided with each raft. Each raft is supplied with two pairs of bellows. The total weight of a raft 24 ft. long and 7 ft. wide is but 420 lbs. The cylinders are of such diameter as to make the whole structure about 32 inches deep, and it draws about 7 inches of water from foot of keel when fully loaded. With this exceedingly small weight it is very readily transported from place to place, launched into the breakers from the beach or from the deck of a vessel; in fact, one person can put it overboard from a ship with the simple precaution of attaching a line to prevent its escape. On account of its elasticity, it can not be broken from collision with the vessel's side, while its extreme buoyancy precludes the possibility of its being swamped in the sea, and it is practically impossible to overturn it; while in the extreme contingency of its being turned over in the water it can not sink, and is in most respects as good and safe a retreat as before such a mishap. Each raft will carry from 75 to 100 persons safely, and will sustain all that can be gotten upon it temporarily, or can cling to the life-lines and floats. Its buoyancy is equal to about 8000 pounds. The cylinders can be carried inflated or not as occasion will permit, while the process of inflation occupies but a few minutes. The material of which the cylinders are composed will withstand variations of temperature beyond what can ever be experienced between the extremes of the tropical and frigid climates.

With the above characteristics, it is beyond comparison with any thing in the form of a boat, and embodies most of the essentials to a perfect apparatus for the saving of life at sea.

Metallic life-boats, such as are carried on shipboard, weigh from 2000 to 2500 lbs., and require the services of a large fraction of a ship's crew to put them in the water, which operation often results in the partial destruction or swamping of the boat, neither of which is possible with this apparatus; and it can be stowed away in a tithe of the space required for a boat, or it can be suspended from davits as well, if thought desirable.

Very successful trials were made with it in 1875 at Isles of Shoals, Cape Cod, Bridgehampton, L. I., and Long Branch, under officials of the United States Navy, and under the Bureau of the Life-Saving Service at other points on the coast. Admiral Porter gives unqualified indorsement to it, in the remark that "no vessel should go to sea without one." It has been adopted for use in the United States Navy and for the life saving stations on the coast, and has been recommended for adoption by the Coast Survey and by the Supervising Inspectors of Steamboats. The largest steamers of the Pacific Mail S. S. Co. are now carrying them.

Beside the two on exhibition under the Machinery Bureau, the Life-Saving Bureau have one on exhibition in the Government Centennial Building.

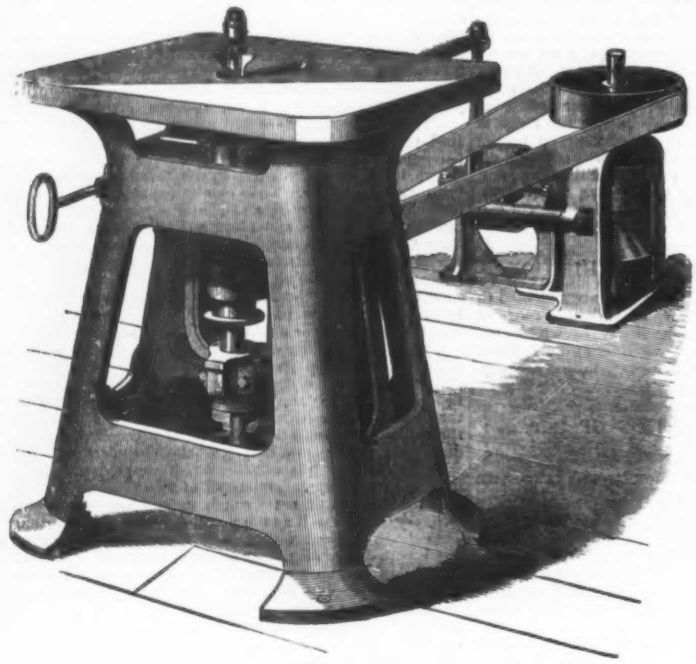
There are very few of us who "go down to the sea in ships" but would essay a voyage across the boisterous Atlantic with greater confidence in our safe arrival, or at least of final survival in case of disaster, if the vessel were supplied with this admirable device.

The raft is manufactured by the Rider Life-Raft Company, of which Mr. John Roach, of iron-shipbuilding fame, is President, and Mr. George B. Stetson, mentioned elsewhere in this letter, Secretary and Treasurer. A careful examination of this invention will well repay all who are interested in such matters.

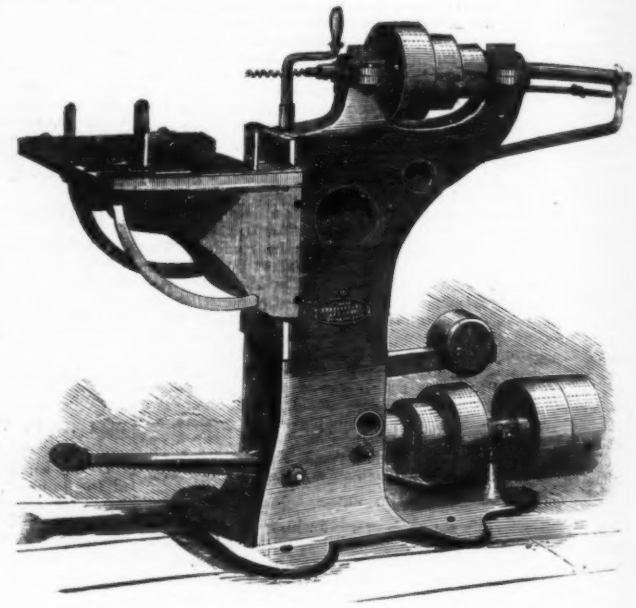
In my last letter on the American Iron and Steel Exhibits in the Main Building, I overlooked those of the Edgar Thompson Steel Works of Pittsburg, Pa., and the Keystone Bridge Co. The former, in the way of steel rails, is a most remarkable one. Among the samples shown of this specialty is the longest steel rail ever made, measuring 120 ft. and weighing 62 lbs. to the yard, or a total of 2480 lbs.; and there are others of 98, 81, and 62 ft. long. They also exhibit some very excellent specimens of work and material in shape of locomotive connecting and side rods, of Bessemer steel. They have also an exceptionally fine specimen of the same metal in a single steam-engine crank of the following dimensions: outside diameter of large size, 25 inches; inside, 14 inches; small eye, 13 inches outside and 6 inches inside; thickness through large eye 12 inches, through small eye 11¼ inches; length between centres 22 inches. Another interesting object of theirs is a Bessemer ingot, compressed by a steam process and finished all over to show the absence of air-bubbles on the surface, the formation of which is prevented by this process.

The Keystone Bridge Co. show an elegant and elaborately constructed model of a swing bridge which has been erected by them on Raritan Bay. It has the largest swinging span in the world, being 472 ft. long, swung upon a central pier. They also exhibit several details of the great St. Louis bridge, one of which is a particularly fine piece of work and engineering design.

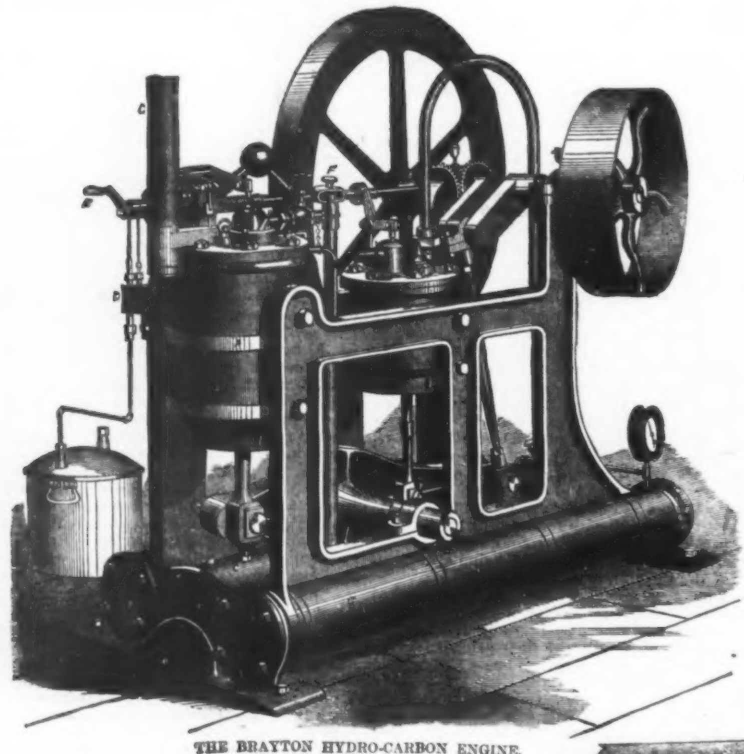
J. T. H.



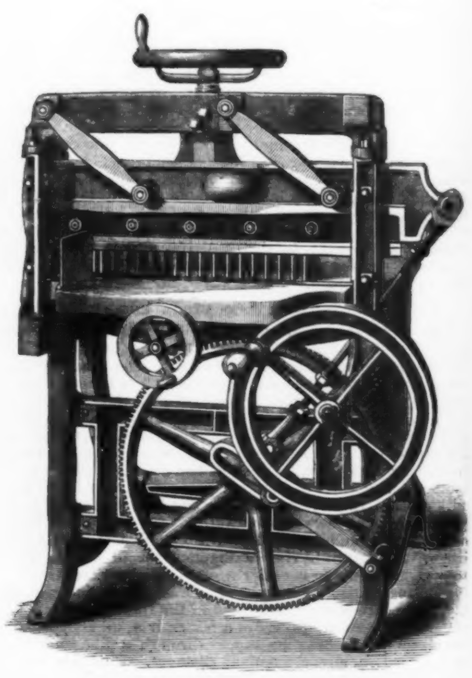
BENTEL, MARGEDANT & CO.'S MOULDING MACHINE.



BENTEL, MARGEDANT & CO.'S BORING MACHINE.

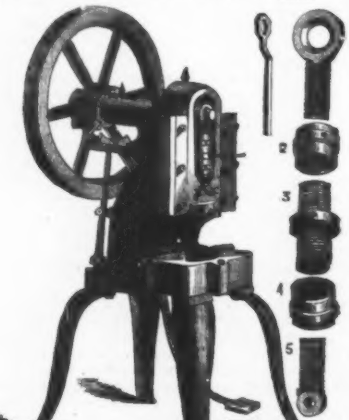


THE BRAYTON HYDRO-CARBON ENGINE.

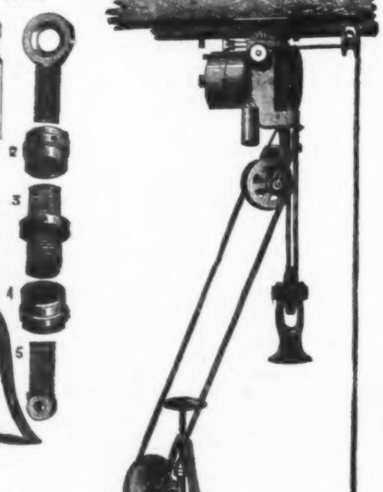


BROWN & CARVER'S PAPER CUTTER.

FERRIS & MILES' STEAM HAMMER.



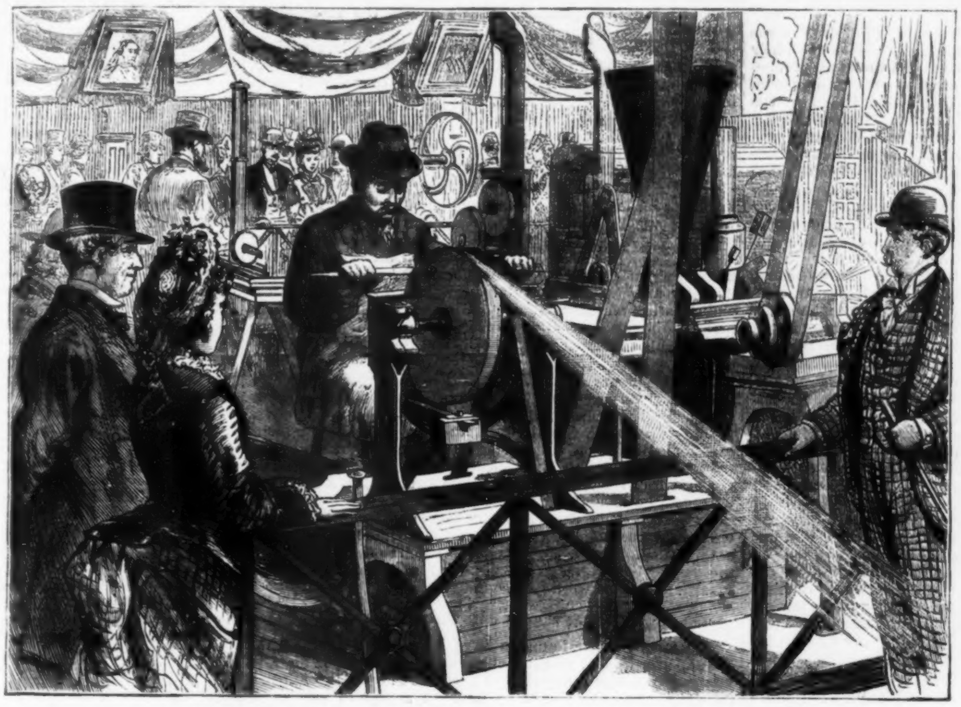
MERRIMAN'S PUNCHING PRESS.



THORNE, DeHAVEN & CO.'S DRILLING MACHINE.

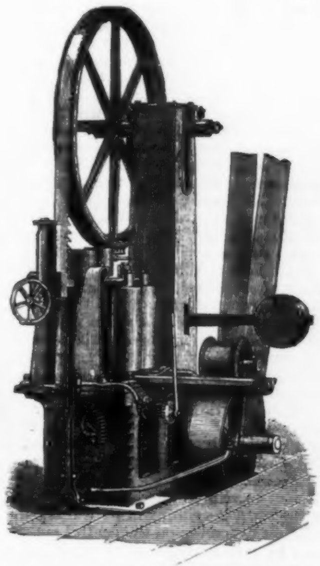
DAUGHADAY'S PRINTING PRESS.

THE INTERNATIONAL EXHIBITION OF 1876.

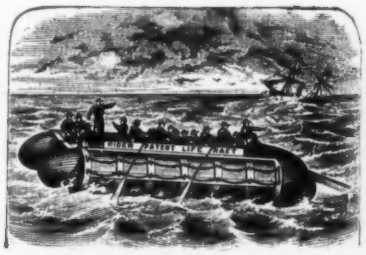


BAYONET POLISHING AT THE EXHIBITION.—(*See page 529.*)

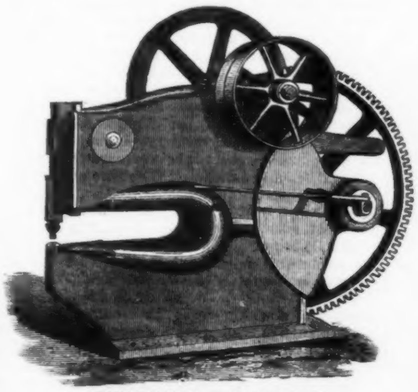
J. A. FAY AND CO. PATENT VARIETY WOOD-WORKER.



J. A. FAY AND CO.'S BAND SAWING MACHINE (FRONT SIDE).

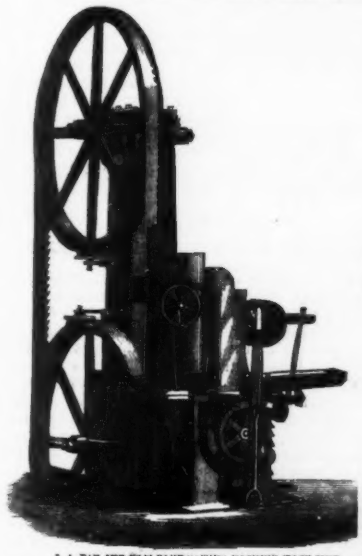


RIDER'S LIFE RAFT.

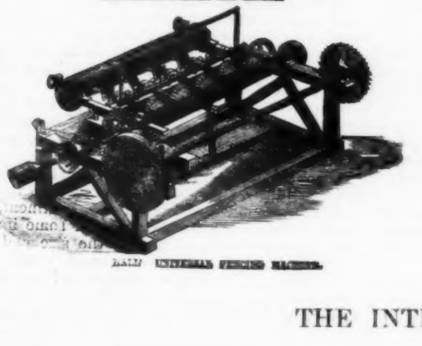


FERRIS AND MILES' POWER PUNCHING PRESS

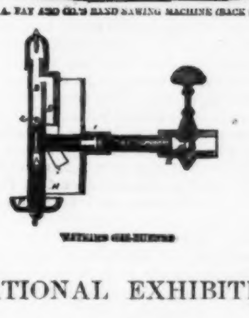
HAMILTON'S STEELED CAR WHEELS.



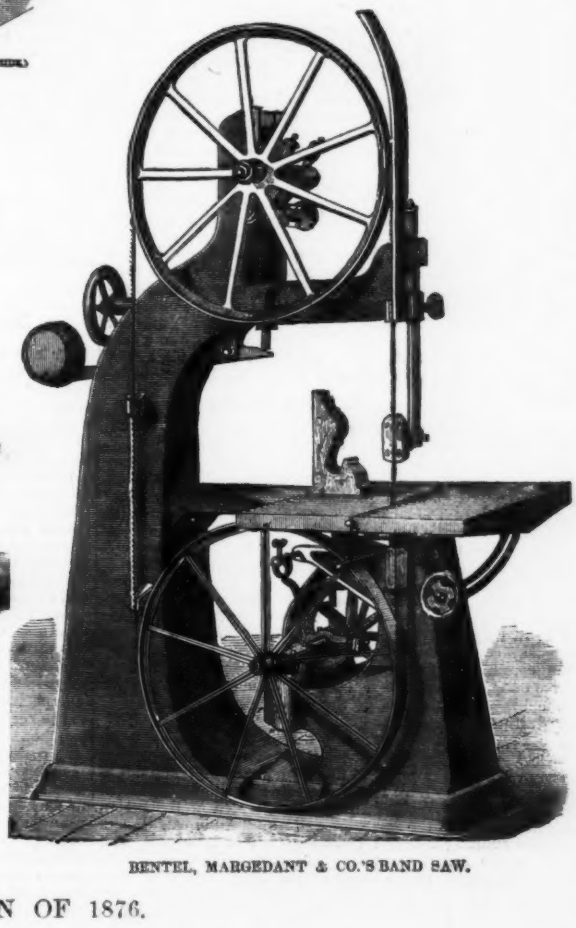
J. A. FAY AND CO.'S BAND SAWING MACHINE (BACK SIDE).



BAILY UNIVERSAL FEEDING MACHINE.



WATKINS GAS-BURNER.



BENTEL, MARGEDANT & CO.'S BAND SAW.

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ILLUSTRATIONS OF THE EXHIBITION.

Messrs. J. A. Fay & Co., of Cincinnati, Ohio, show some of the best wood-working machines in the Exhibition. Their patent variety wood-worker performs a great number of operations, no less than twenty-six varieties of work being shown on a diagram of the capabilities of this tool issued by the makers, but these may be practically reduced to about fifteen different classes. The iron platens are planed perfectly true and have independent vertical and lateral adjustments. The vertical adjustment is very quickly made by means of hand wheels and bevel gear, placed in the most convenient position for the operator. When facing or planing out of wind, the vertical and lateral adjustments can be made simultaneously, thus constantly retaining the proper distance between periphery of cut and the edge of table. All of the different functions of the machine are secured by the use of two tables, while other machines of this kind have three tables, thereby effecting a saving of time in making adjustments. The tables or platens are made with grooves to receive the gaining frame, and are made continuous by hard-wood filling pieces connecting the two tables at each side. For sawing, an extra table can be inserted between the other two, making a solid and continuous saw table. The arbor is of steel, of large diameter, and revolves in bearings supported on the column. One bearing is cast solidly to the column, and the other is movable, being planed in a seat, the height of which to the centre of the arbor is equal to one-half the diameter of the largest head to be used. The movable or outside bearing is readily detachable for the purpose of substituting different heads by loosening a bolt at the bottom. This is a very important and advantageous feature, as it gives greater stability to the arbor, and obviating its liability to spring, renders the machine capable of performing a larger range of work. Another very important advantage will be found in the fence, which requires no separate adjustment. Being attached to and forming a part of the forward table, it always maintains its proper position in relation to the knives. The fence has lateral adjustment, is fitted to receive pressure springs for holding down the stuff, and swings to different angles for bevelling work. Each machine is provided with an 8 in. three-knife planing head, rabbeting, jointing and capped heads, and is fitted to receive expansion gaining head and panelling heads, and when desired can be fitted on opposite sides with boring and routing table, which has vertical and lateral adjustments to suit the size of the stuff being worked. Of course Messrs. Fay & Co. exhibit a band saw, without which no stand of wood-working machinery would be complete, and the upper wheel is made of steel with india-rubber tire, which, from its lightness and elasticity, reduces the strain upon the saw when starting and stopping. The four-roll planing and matching machine has two important features, one being that the whole of the front portion of the frame, with the feeding rolls, can be swung to one side, and thus gives ready access to the cutter heads. The matcher heads can be quickly lowered below the frame by means of two square keys when it is desired to plane only. The beading attachment is placed upon the pressure bar over the under cylinder, so as to gauge the depth of the bead from and by the surface of the board, and secure automatic adjustment of the beading shaft at all times. A double-deck planer is used for thicknessing or truing on one side only; their universal wood-worker is a moulding machine, with a "Variety" machine, previously described, attached to it, and is a very compact and useful article for performing a great number of operations. The patent band re-sawing machine is provided with a great number of adjustments, the most important being a strut, not shown on the cut, which gives outside bearings to the upper and lower wheels. It consists of a hollow rod, furnished with an india-rubber spring buffer at its upper end, and a screw coupling at the centre by which the pressure on the outside bearings can be regulated. The wheels are 5 ft. in diameter, and the distance between their centres is such that there is but a comparatively small portion of the saw blade left unsupported, and consequently less liability to deviate from a straight course. The tendency of the saws to "run" has hitherto been a serious drawback in the use of a band saw for re-sawing. The upper wheel revolves on a $2\frac{1}{4}$ in. shaft, running in long self-oiling bearings, has a vertical adjustment of 12 in., and can be adjusted so that the saw will run at any desired point on its periphery. The feed rolls are connected by expansion gears, operated by friction. This friction is operated by a shaft connected with a lever in front of the column, by different movements of which the feed is instantly started or stopped, and graduated from fine to coarse. The feed is strong and powerful, and is under complete and immediate control of the operator. The feed rolls are adjusted to and from each other by levers attached to their sliding frames, operated by hand-lever rack and pinion. The hand-lever is retained in position by ratchet and pawl, and a sufficient pressure can be obtained to take out any warp in the stuff being sawed, and the feed rolls next the column can be fixed as guide rolls in any desired position. The machine is fitted with patent roller guides for the back and sides of the saw, which form a perfect guide for the saw and prevent "buckling." They are always in a true vertical line with each other, and the upper guide has a vertical adjustment to suit different widths of lumber being worked.

The American File Company of Pawtucket, Rhode Island, and the Nicholson File Company, of Providence, Rhode Island, display beautiful collections of every known variety of file.

Messrs. Hoopes & Townsend, of Philadelphia, exhibit car-forgings, bolts, nuts, rivets, and chain-links, of the highest excellence of workmanship, and well arranged, including beautiful nuts, said to be punched cold; also specimens bent and broken to show the quality of the materials. In fact, one of the most important and interesting features of the Exhibition is the large display of manufactured articles and tools, and also samples of castings and forgings, seamless and welded tubes, etc. The castings comprise a large water-main for the Croton Aqueduct at New York, 72 in. diameter and 12 ft. long, exhibited by Messrs. R. D. Wood & Co., of Philadelphia. These articles are nearly all very tastefully arranged, and are interesting to examine, and prove the high degree of excellence to which American manufacturers have attained in the production of these articles, which were formerly all procured from England.

The Pottstown Iron Company, whose works are at Montgomery County, show specimens of ore raised from their own mines in Chester County, and fine iron plates 18 ft. by 6 ft. 6 in. by $\frac{3}{8}$ in., said to have borne a tensile strain of 45,000 lbs.—20 tons 2 cwt. nearly—per square inch, which were used in the construction of the steamships of the "American" line of steamers running between Philadelphia and Liverpool, and in which the Americans take great pride. The public are, however, attracted to the stand of the Pottstown Iron Company by a very noisy nail-making machine, which turns out about 200 nails per minute, in sizes of 2 in. to $4\frac{1}{2}$ in. long; the most noticeable feature about this machine is an automatic feeding arrangement, which supplies the materials of which the nails are made.

The Duncannon Iron Company, of Philadelphia, also show a nail-making machine, which is fed by hand. The iron bar, of a width corresponding to the length of the nail to be made, is held under the cutter, a spring at the back of the cutter regulating the width of the strip; the latter is then held by the machine while the head is formed by a die. This machine can produce 300 $1\frac{1}{8}$ in. nails per minute, and can make them from $\frac{1}{2}$ in. to $1\frac{1}{2}$ in. long.

The Pennsylvania Tack Works show some very delicate machines for making every variety of tacks. They are fitted with various improvements in the form of the levers and feed motion, but as these are not yet protected by patents in Europe, I am not at liberty to describe them in detail. The machines make 400 revolutions per minute, each revolution manufacturing a tack, and they are stated to be the smallest and lightest machines that have been introduced for tack-making. One thousand of the largest tacks produced by the instruments exhibited weigh 6 ozs., and the smallest are very minute.

The Old Colony Rivet Works, of Kingston, Massachusetts, have some very neat and useful handshears, for cutting bar and plate iron; also four hand planing-machines to plane various sizes, from 8 in. by 8 in. to 2 in. by 2 in.; but the greatest novelty on their stand consists of an improved ratchet drill, having a vertical, diagonal, and horizontal movement of the lever. The lever is attached, by a universal joint, to a horizontal lever wheel working between two vertical wheels; the reciprocating movement of the lever in a horizontal position turns each of the vertical wheels alternately, thus giving a continuous rotation to the brace, while the facility of moving the lever in any desired direction greatly facilitates work in a confined space.

ATWOOD'S CAR-WHEEL.

The American ironfounders have long been celebrated for the superior quality of their chilled cast-iron wheels for railway and tramway purposes, and I believe most of the English tramway companies find it to their advantage to import the wheels for their cars from America. The exhibition of chilled wheels is a large and interesting one, but it is somewhat singular to find the inventor of the most approved form of this class of wheel has abandoned his original ideas, and adopted a new form, with steel or wrought-iron tires. The drawing will explain the new method of construction adopted by Mr. Atwood, of Brooklyn, for securing the tire, by which the use of bolts or rivets, and the shrinking of the tire upon the body of the wheel, are dispensed with. The wheel is composed of the boss of the wheel B, the spokes, C and C^2, connecting the boss and the rim D, in which are cavities forming a corrugated surface, and the flange F, on which the pins or lugs G G are cast. The tire is made with two cavities, I I, on its inner surface, forming a corrugated surface, and on the flange side of the tire are holes to receive the projections G G. The form given to the tire A, by the cavities on its inner surface, leaves the thickest part of the tire under the central portion of the tread. When the tire is laid upon the flange F, the pins G G will enter the holes or sockets H H, which are made a little larger than the pins, so that they should not touch. When the tire is placed on and fitted to the body of the wheel, there should be an opening of about $\frac{1}{4}$ inch at L, between the tire A and the rim D, through which the packing is to be done. A space is left between the tire A and the rim D, forming an annular chamber K, which is larger within than at its orifice L, and this chamber K is packed with hemp, cotton, or other fibrous material, forming a cushion, sustaining the whole weight of the load upon the wheel. This packing, which fills the cavities I I in the tire A and the cavities E E in the rim D, interlocks and secures the tire to the body of the wheel without the necessity of using bolts or other fastenings, thus doing away with all metallic connection between the tire and the body of the wheel in the line of force of the blows, the pins or projections G G serving the purposes simply of preventing the tire from turning or sliding around upon the central portion or body of the wheel, or, in case of fracture, from flying off. The hemp, cotton, or other fibrous material, moistened with glycerine, is to be inserted into the chamber K, one strand after another, each being consolidated by packing, using mallets and caulking tools, filling the chamber K piece by piece, and driving each one down as long as any can be forced into the aperture. After the chamber K is perfectly filled with the packing, the narrow space L, through which the packing has been done, should be filled with lead or other soft metal to make it watertight. The edge of the tire is then to be turned off, and the dovetail groove N cut into the rim D, into which groove the rim M is to be shrunk. The office of this ring is to prevent the packing from coming out, and to keep it dry. This ring should be turned off to give it a finish.

DRAWING FROM THE MICROSCOPE.

AT a recent meeting of the Natural History Society, of Gottingen, Dr. H. Holle exhibited his new apparatus for drawing from the microscope. The principle of his is that neither the drawing-pencil itself nor its reflection is seen, but a collective picture of the whole is brought into view by a combination of lenses. To effect this the eyepiece of the microscope in its ordinary position is made to serve also for a telescope fixed at about the distance of the height of the microscope; the axis is twice reflected at right angles by mirrors. The first, and, of course, transparent mirror, is placed immediately under the eyepiece, and the second is above the object-glass of the telescope. The first is of the greatest tenuity possible (about $\frac{1}{4}$ of a millimetre thick), in order that the images of the pencil transmitted by the upper and lower faces of the glass may fall together. The mirror above the objective, on the contrary, should be of moderate thickness, or it may be replaced by a prism. Between the two mirrors there is a lens which again transposes the inverted image of the pencil. In using this apparatus the microscope-image is seen in a direct manner without tiring the eye. The position of the hand occupied in drawing is immediately to the right of the microscope, the most comfortable position possible. The picture is drawn without being reversed, and on a scale answering to the objective employed, and an eyepiece of low power. When an objective of low power is used it is necessary with this apparatus as with every other to darken the field of vision in order that the image of the pencil may be distinctly seen, but when an object-glass of high power is employed, or the object itself is more opaque, it is sufficiently conspicuous. Dr. Holle asserts that he has drawn thick sections of meristematic tissues easily, which it would be impossible to do even with Oberhauser's apparatus.

RECENT DISCOVERIES OF EXTINCT ANIMALS BY PROFESSOR MARSH.

IN a lecture to the Graduating Class of Yale College, delivered in the new Peabody Museum, June 3d, Professor O. C. Marsh gave a brief *résumé* of the more important results of his late palæontological researches in the Rocky Mountain region. His explorations, which were attended with much hardship and danger, have been mainly confined to the Cretaceous and Tertiary formations, and especially to their vertebrate fauna. During the past six years, the expeditions under his charge have brought to light more than 300 species of fossil vertebrates new to science, about 200 of which he has already described.

Among the extinct animals thus discovered, were many new groups, representing forms of life hitherto unknown. The most interesting of these are the Cretaceous *Odontornithes*, or birds with teeth, which constitute a new sub-class, containing two distinct orders, namely, the *Odontolcæ*, which have the teeth in grooves, and the *Odontotormæ*, with teeth in distinct sockets. The former were swimming birds of gigantic size, with rudimentary wings, and the vertebræ as in modern birds. The type genus is *Hesperornis*, and three species are known. The second order embraces at present only small birds with powerful wings, and biconcave vertebræ. The type genus is *Ichthyornis*, and the geological horizon is upper Cretaceous. Another discovery of importance from the same formation was Pterodactyls, or flying reptiles, the first detected in this country. These are of much interest, on account of their enormous size—some having a spread of wings of more than twenty-five feet—but especially as they were destitute of teeth, and hence resembled recent birds. They form a new order, *Pteranodontia*, from the typical genus *Pteranodon*, six species of which are now known. With these fossils were found large numbers of Mosasauroid reptiles, and remains of more than 500 different individuals were collected. These proved to belong to two new families, *Tylosauridæ* and *Edestosauridæ*. Some of the former attained a length of sixty feet, while the latter were much shorter, the smallest being less than ten feet. These groups included several new genera and many species. This large series of specimens enabled Professor Marsh to clear up many doubtful points in the structure of these reptiles, and to determine that they possessed hind paddles, and were covered, in part at least, with bony dermal scutes. Many other birds, reptiles and fishes were found in the same Cretaceous strata.

The discoveries of Professor Marsh and party in the Tertiary of the West were of no less importance. The most interesting are those made in the two Eocene lake-basins between the Rocky Mountains and the Wahsatch Range. These basins were explored by Professor Marsh in 1870, and their Eocene age then first determined. His explorations in this region have secured to science over 150 species of new vertebrates, most of them widely different from any hitherto known. The most remarkable of these are the gigantic mammals of the new order *Dinocerata*, the type genus of which is *Dinoceras*. These animals nearly equalled the elephant in size, but the limbs were shorter. The skull was armed with two or more pairs of horn-cores, and with enormous canine tusks, similar to those of the walrus. The brain was proportionally smaller than in any other land mammal. Three genera and several species are known. Remains of more than 100 distinct individuals were obtained, and are now in the Yale Museum. The *Tillodontia* are another new order of mammals discovered in the same Eocene deposits. They possess many remarkable characters, which indicate affinities with the Carnivores, Rodents, and Ungulates. There are two well-marked families, the *Tillotheridæ*, from the typical genus *Tillotherium*, which has rodent-like incisors; and the *Stylinodontidæ*, in which all the teeth grew from persistent pulps. The largest of these peculiar animals was about the size of a tapir. One of the most interesting discoveries made by Professor Marsh in the Eocene of Wyoming was the remains of Quadrumana, the first found in the strata of America. These early Primates appear to be related both to the lemurs of the old world, and to some of the South American monkeys. Two families are known, the *Lemuravidæ*, from *Lemuravus*, the principal genus, which has 44 teeth, and the *Limnotheridæ*, which have not more than 40. The latter group is rich in genera and species. Among the other Eocene mammals discovered were marsupials and bats, not before known in a fossil state in this country. One of the most important Eocene mammals found was a small ungulate, which is the oldest known ancestor of the horse. It was about as large as a fox, and had four toes before and three behind. The genus was named *Orohippus*, and several species were discovered. These remains, in connection with others from the later Tertiary, enabled Professor Marsh to trace the line of descent which has apparently produced the modern horse. In addition to the Eocene mammals, many species of birds, serpents, lizards, and other vertebrates were collected.

The discoveries made by the same expeditions in the Miocene and Pliocene lake-basins of the Rocky Mountains and Pacific coast were likewise very numerous, and many new forms of animal life were brought to light. One group of mammals found in the early Miocene of Oregon is allied to the modern *Rhinoceros*, but differs in having a transverse pair of horn-cores on the nasal bones. The genus was called *Diceratherium*, and one of its species is the oldest known member of the rhinoceros family, if not its progenitor. The most remarkable mammals found in the Miocene were the huge *Brontotheridæ*, which are apparently allied both to the above group and to the Eocene *Dinocerata*. They equalled the latter in size, and had also an elevated pair of horn-cores on the maxillary bones. One genus of this family was previously known by imperfect specimens. Besides *Brontotherium*, several other new genera of this group were found, represented by portions of over 200 individuals. With these remains was discovered a genus of small equines, *Mesohippus*, about as large as a sheep, and having three toes on each foot, with an additional "splint" bone on those in front, thus forming an interesting Miocene link in the genealogy of the horse, completed by the Pliocene genera. Over 30 species of fossil horses were collected in these formations. Among the interesting animals obtained in the Pliocene deposits were two species of large Edentates, the first Tertiary representatives of this order from America. They belong to a new genus, *Morotherium*. There were also found large numbers of rhinoceroses, camels, suillines, and other mammals, as well as many birds, reptiles, and fishes.

A study of the large series of extinct animals thus collected, and now in the Yale Museum, promises to throw much light on the development of life on this continent, and Professor Marsh has already drawn from them some important principles. One of these relates to the size and growth of the brain in mammals, from the beginning of the Tertiary to the present time. The conclusions reached may be briefly stated as follows: first, all Tertiary mammals had small brains; second, there was a gradual increase in the size of the brain

during this period; third, this increase was mainly confined to the cerebral hemispheres, or higher portion of the brain; fourth, in some groups, the convolutions of the brain have gradually become more complicated; fifth, in some, the cerebellum and olfactory lobes have even diminished in size. There is some evidence that the same general law of brain-growth holds good for birds and reptiles from the Cretaceous to the present time.

Some additional conclusions in regard to American Tertiary mammals, so far as now known, are as follows: first, all the *Ungulata* from the Eocene and Miocene had upper and lower incisors; second, all Eocene and Miocene mammals had separate scaphoid and lunar bones; third, all mammals from these formations had separate metapodial bones.

In conclusion, Professor Marsh stated that his work in the field was now essentially completed, and that all the fossil remains collected, and in part described, were now in the Yale College Museum. In future, he should devote himself to their study and full description; and hoped at no distant day to make public the complete results.—*American Journal of Science and Arts.*

THE MANUFACTURE OF CHILLED ROLLS.

Until within the past few years the casting of chilled rolls has been attended with considerable risk, and frequent loss; often a half dozen or more would be cast before a good one could be obtained; and your readers will likely call to mind of reading an advertisement in your paper offering a large sum of money for information which would enable the advertisers to make chilled rolls without cracking or splitting.

The parties who were successful in making chilled rolls kept their process, and mixtures of iron for the purpose, a secret, it being the result of years of experience and costly experiments to determine the best and most suitable grades of pig metal, to ensure hardness of surface or chilling qualities, and yet to have a tough, strong, tenacious interior or body, in order to enable the roll to wear regular and well at its surface, and to be strong enough to withstand the sudden shocks and severe usage to which they are subjected. This point of itself was not so difficult to attain, and when reached, another more serious one presented itself, for a mixture of iron which would meet the above requirements would often be found to have different degrees of contraction in cooling, so that a cracked or split roll was the natural consequence. This difficulty has in a measure been overcome, yet there is still some uncertainty about the result, though the different brands of iron are selected with great care, and accurately weighed, mixed, and smelted, for the purpose; and with the same chills, and under the same conditions and circumstances, a bad, defective roll will occasionally be made. So uncertain is the result that, notwithstanding the great care used, it is found necessary, before risking the shipment of any chilled rolls in the rough or unturned state, to put them in the lathe and take a cut off each end of the body, to ascertain the depth and quality of the chilled surface. Sometimes the chilled face is very uneven as to depth. Such rolls would be unsuited for bars, bolts, etc., as the grooves in the rolls would cut through the chilled iron, and into the soft iron of the body, at the shallow or thin places, thereby making the roll unfit for the purpose intended. Another uncertainty which is often met with is the depth and grade of the chilled surface. It is desirable in large rolls particularly, that the chill be of a mild or medium degree of hardness, and of good depth; but often a shallow chill is an extremely hard and harsh one, and *vice versa*, a deep chill, too soft. Those are a few only of the troubles encountered in the casting of chilled rolls, and they are met with when under like conditions and circumstances as to mixtures of iron and proportions thereof, a first-class roll is obtained.

This article suggested itself to our mind upon visiting the foundry of A. Garrison & Co., of this city, where there has been just finished a beautiful pair of chilled rolls, the largest ever made in this country, and said to be the largest made anywhere. They are to be used in the plate mill of Messrs. Pennock & Co., of Coatesville, Pa. Their dimensions are as follows: Diameter of body, 30 inches; length of body, 9 feet 2 inches; diameter of necks, 20 inches; length of same, 14½ inches; and weight, when finished, about twenty-six tons per pair. This same firm have made chilled rolls one inch larger in diameter, but only eight feet long, for a plate mill in Buffalo, N.Y., they being considerably shorter than the above.

The massive chills or cylinders in which those rolls were cast are over twelve inches thick in their sides, are bored out, and faced true. When the metal for the roll is poured into them, they expand by the heat of the liquid metal. The metal in the roll contracts as it congeals, so that when the roll is sufficiently cold to remove, the chills are found to be quite loose, and are easily taken off the roll. The lathes in which those rolls were turned were built especially for this heavy work, and are what are known by roll-turners as the "Hercules" type or pattern of roll-lathe, and in which two tools are operating at the same time, having a cutting edge of eight inches *each*.

The cutting speed on these rolls was one revolution in three and a half minutes, or about twenty-seven inches per minute with a medium chill, the hardness of which, of course, regulates the cutting speed.

On roll turning-lathes—particularly those for chilled work—there is no feed arrangement, as there is on machine-lathes; but the cutting tools are forced square up to the roll by wedges driven behind them, until the work is reduced to nearly its finished size. The tools are then moved along on the rest, the width of the cut being usually about 8 inches, when another cut is taken by each tool, and so on until the roll is finished.

To those of your readers who have not noticed the operation of roll-turning, I will explain that all rolls are first "necked," as it is technically termed—that is, the necks or journals are turned to their proper size and shape. This is done on a dead centre, in order to have true necks. They are then placed in a pair of housings or journals, which are secured at suitable distances to the bed of the lathe, and made to revolve on their necks, by which the body is turned perfectly true.

In rolling gold, silver, or other fine metals or alloys, a greater degree of accuracy is required in the rolls than can be produced by turning alone. The fine wrinkle or chatter, though scarcely perceptible to the eye, must be removed; and when such is demanded, the rolls are placed in a polishing machine, in which they are made to revolve slowly in one direction, whilst a pair of emery wheels revolve at a high velocity in an opposite direction, and at each side of the roll, and also traverse across the face of it. The emery wheel at first merely strikes the high places, and as fast as it reduces them is fed in until a true, polished, and beautiful surface is obtained.

T. J. B.

Pittsburgh, July 10th, 1876.

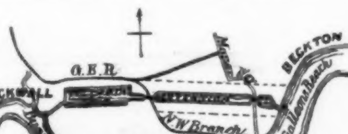
REPAIR OF A FURNACE CRUCIBLE WHILE IN BLAST.*

The Quinnemont Furnace (60×15 feet) had been in operation but two months when it became necessary to draw the tuyeres out a distance of eighteen inches, in order to give them a resting-place; the brickwork under them being completely cut away, so that after each cast they would sink from 6 to 8 inches, requiring a loss of from 1 to 1½ hours in raising and re-setting. The tuyeres had been intentionally retained in their original position as long as practicable, in the hope that the cutting out would be retarded. This, however, did not prove to be the case, the process of destruction continuing as rapidly as ever.

The original thickness of the crucible wall (3 feet) was now reduced to 18 inches, and breaking out of iron was a frequent occurrence. As a still further protection, a wall of brick was carried up, encircling the hearth, with an annular space of 3 inches, which was filled in with fragments of fire-brick, upon which a constant stream of water was kept flowing at several points. This did not suffice to preserve the brick, for, at the expiration of a month, the walls had become so thin that the tuyeres could not be maintained even in their new position without great loss of time in resetting. The quantity of fire-brick and clay used in the operation eventually mixed in with the iron, so that the old experience of fire-brick and iron not working well was repeated with monotonous regularity at each cast. The settling of the tuyeres finally culminated in one falling into the furnace, when it was decided to attempt to re-build the hearth in sections, and at intervals. A section of the crucible measuring 7 feet on the outer circumference, 4 feet on the interior, and 4 feet high, was first removed. Commencing at the open tuyere arch, the air was excluded, and stock held back with a heavy body of clay, tightly rammed with fire-brick, and driven back simultaneously, with the removal of the old work, and far enough to admit a 30-inch wall being set in with 15-inch blocks, 6 inches thick. The entire operation required 30 hours; quite a flow of cinder and some iron occurred as the last two courses of brick were raised, but was readily removed, and did not prevent a clear foundation being secured, 6 inches below the level of the hearth bottom. Two weeks later, a section 5×3×4 feet was taken out on the opposite side, and rebuilt in the same manner, and, later still, repairs of a similar nature were carried out in the back arch. A rising of the brick was anticipated, but did not take place, and beyond a slight bulging no trouble was experienced. The iron was kept very gray for several weeks, giving an excellent opportunity for the work to close up. The furnace was operated seven months longer without exhibiting any signs of weakness. Eventually the cutting out of the boshes necessitated its going out of blast, and on blowing out, the renewed sections were comparatively intact.—*Engineering and Mining Journal.*

THE VICTORIA DOCK EXTENSION.

Of all engineering projects in the metropolitan district brought before Parliament last session, few can lay claim to as much importance and interest to the profession as the Victoria Dock Extension. The Victoria (London) Dock Company, which originally constructed the Victoria Dock, were authorized by an act in 1853 to extend their dock eastward on lands acquired by them, called the Victoria Dock Estate, stretching from Blackwall to Galleons Reach, near Beckton, on the River Thames below Woolwich. The Company not being in a position to execute this Extension, and the time for completing it having expired in 1862, upon the amalgamation of the old London Dock Company and the St. Katharine Dock Company in 1864, the Victoria Dock Company was vested in them, and the London and St. Katharine Docks Company now include the three dock establishments incorporated in one concern. For some years past the present entrance to the Victoria Dock, at Blackwall, has been a constant source of trouble through its insufficient depth, contracted water space, and general inadequacy to the conduct of the very heavy traffic passing through it. These drawbacks, crippling as they did the resources of the dock, at length became so intolerable that the Company determined to avail themselves of their magnificent estate by boldly opening out the dock from its inner end, and extending it eastward towards the river. In 1875 the Company went to Parliament for an act to authorize this Extension, which act they succeeded in obtaining on the 19th of July, and on the 9th of November a contract was entered into for the execution of the work.



By reference to the sketch annexed it will be seen that this Extension fulfils two important purposes. Firstly, it provides a new entrance to the Victoria Dock some 3½ miles lower down the river than the present awkward entrance; and secondly, it largely increases the area of accommodation for vessels in the dock. The importance of these improvements, whether regarded from a commercial or an engineering point of view, can hardly be overestimated. The construction of a new entrance to the dock in a magnificent open water space like Galleons Reach, whereby vessels bound for the Victoria Dock will escape the 3½ miles of intricate and dangerous navigation of Woolwich Reach and Bugsby's Reach, can not but increase the popularity this dock has always enjoyed as the lowest down the river, to the consequently enhanced value of the Company's property in this direction. As an engineering work the undertaking is colossal. The extreme length of the Extension from the present dock to Galleons Reach is 1½ miles. The new dock will be 540 ft. wide at water level, with a minimum depth of 27 ft. below Trinity high water. The entrance lock will be 800 ft. long by 80 ft. wide, furnished with three pairs of gates and with timber jetties extending 250 ft. into the river. The depth of water on the sills will be 30 ft. below Trinity high water. The length of quay walls available for berthage on the completion of the whole scheme will be 9000 lineal feet, besides which there will be 6500 lineal feet of sloped banks. The area of the Extension will be 95 acres, bringing up the aggregate area of the Victoria Dock to no less than 190 acres altogether. The levels of the quays will be 7 ft. above Trinity high water, or about 14 ft. above the existing level of the Dock estate, which forms a portion of the Essex marshes, from which the river is excluded by embankments miles in extent.

The North Woolwich Branch of the Great Eastern Railway crosses the Dock estate at the eastern extremity of the present dock, and to obviate the inconvenience of conveying the heavy traffic of this railway over a swing bridge, it has been decided to take the railway through a covered-way, or tunnel, underneath the passage between the Dock and the Extension, at a depth of 43 ft. 6 in. below Trinity high water, rising and falling on either side at a gradient of 1 in 50. To effect this alteration the railway has already been diverted over a temporary line constructed some distance clear of the site to be occupied by the covered-way—a work in itself of considerable magnitude. A swing-bridge of 80 ft. span will be constructed across the passage for the purpose of carrying a public roadway for carriage traffic, as well as the railways necessary for conducting the business of the dock. The public road known as the Woolwich Manorway, which crosses the Dock estate towards its eastern end, will be carried across the Extension by a swing bridge of 90 ft. span, the space between it and the lock forming a convenient entrance basin, about 10 acres in extent and 28 ft. deep.

The excavations are being carried down through a stratum of peat, overlying the entire area of the Extension, and filled with fallen trees in wonderful preservation, below which lies a bed of gravel, which will be utilized for concrete to build all walls. Below the gravel, where the excavations are being sunk to a greater depth than ordinary to get in the foundations for the covered-way, a stratum of concreted shells and clay has been met with some 30 ft. below the surface of the ground, and various animal remains, as deers' antlers, etc., have been unearthed. Subject as these marshes have been to continual depression during past ages, and having consisted, as the excavations plainly demonstrate, of alternate layers of river mud, forest growth, and estuarial deposit, the opening up of such a vast area of ground can not fail to afford a subject of considerable interest to the geologist and the antiquarian.

Some idea of the vastness of this undertaking may be gathered from the fact that the ground to be excavated to form the Extension amounts to over 3,000,000 cubic yards, and the concrete for the walls to 200,000 cubic yards, requiring 30,000 tons of Portland cement in their construction. Though the works have hardly been in hand six months, considerable progress has already been made. Some 1800 navvies and one steam excavator are daily engaged in filling hundreds of earth wagons, which nine locomotive engines are hauling to bank over some miles of contractors' rails. The completion of this great work is looked forward to in three or four years, at an estimated cost of between half and three quarters of a million sterling.

The engineer from whose designs the work is being executed is Mr. A. M. Rendel, M.A., M. Inst. C.E., and the Resident Engineer is Mr. A. C. Andros, M. Inst. C.E. The contractors are Messrs. Lucas and Aird, under the direction of whose manager, Mr. W. Colson, the works are being prosecuted with a vigor and energy which leaves nothing to be desired.—*Engineering.*

POINT BRIDGE, PITTSBURG, PA.

We present an illustration of the Point Bridge over the Monongahela River, at Pittsburg, Pa., now in process of construction by the American Bridge Company, from the designs of Mr. Edward Hemberle, one of the engineers of the company. Mr. Hemberle and his associate, Mr. Coolidge, have designed some of the finest and largest structures of this country.

Point Bridge is to accomplish what was years ago intended to be obtained by the *tripartite project*—namely, to connect the city of Allegheny with the Pittsburg Point, and the latter with the south shore of the Monongahela River by the shortest line possible.

Union Bridge, already built, connects Allegheny with the Point, and Point Bridge is to connect the Point with the south shore of the Monongahela River. Mr. Chas. Davis, City Engineer of Allegheny and Consulting Engineer of the Point Bridge Company, located the bridge, and his original specifications were made for a cable suspension bridge, with a centre span of 800 feet centre to centre of towers, and two trussed side spans 110 feet and 150 feet in the clear respectively. The height of floor above mid-channel of river, 290 feet from south tower, was fixed at 83 feet above low-water mark.

Bids for building the bridge were received in the spring of 1875, with the understanding that they might be for cable suspension, according to specifications, or for any other plan submitted.

Proposals were made by most of the prominent bridge-builders of the country, based on various plans—namely, Roebling's cable suspension, braced arched, Ordish system, cantilever, old style chain suspension, and the stiffened chain suspension. The plan adopted was the stiffened chain suspension, designed by Mr. Edward Hemberle, Engineer of the American Bridge Company, to which company the contract for building the bridge was awarded. Its total cost will be $450,000.

The illustration shows the elevation, plan, and cross-section of the bridge, and the details of the towers. The centre span is 800 feet centre to centre of towers, and the side spans are 145 feet each in the clear. The height of the towers above low water is 180 feet, and the deflection of the chain is 88 feet. The roadway is 20 feet wide, with double tramways, and one track for a narrow-gauge railway; outside of the roadway are sidewalks six feet wide each.

The piers and anchorages are founded upon timber platforms sunk to a gravel bed. The masonry is of best quality Baden sandstone.

The superstructure will be the first example of a stiffened chain suspension bridge of long span, and will differ considerably from others in existence. The chain is designed as a catenary, and will take up all the permanent load of the structure without bringing strains on the stiffening trusses. This object will be accomplished by erecting the bridge completely before connecting the ends of the straight top chords to the centre joint. The tie-rods are provided with turn-buckles, and will be so adjusted as to be strained under moving loads only. When the bridge is half loaded, the top chords of the trusses on the loaded side will be in compression, and of the unloaded side, in tension. The maximum strains for the different members of the trusses occur under different positions of the moving load.

There are lateral and vibration braces between the top chords, and also between the chains, proportioned to take up the strains from wind-pressure upon chains and trusses. The

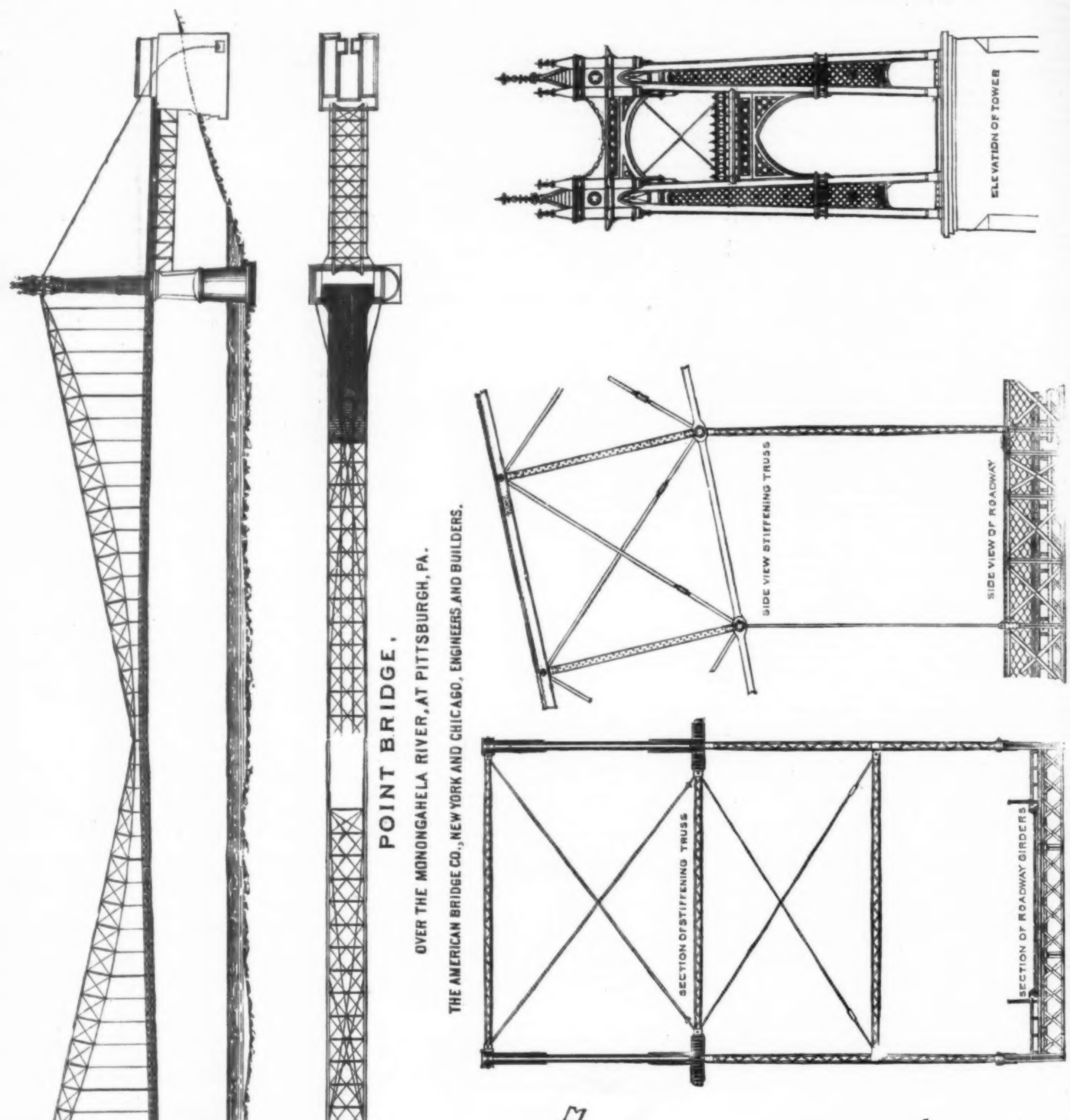
* A paper read before the American Institute of Mining Engineers, at the Philadelphia meeting, June, 1876.

floor is 34 ft. wide between the stiffening girders, which are 8 ft. high, forming the hand-rails. The stiffening girders have expansion joints every 100 feet, and are suspended from the chains by flat bars 20 feet apart. At the expansion joints there are struts instead of suspenders, in order to make a rigid connection between the roadway trusses and the chains. Cross-girders, 3 feet in depth, connect the stiffening girders every 20 feet, and support two lines of iron stringers. These stringers and the roadway trusses form the bearers, across which are placed the wooden joists for the flooring

The lateral stiffness of the floor is secured by a double system of tie-rods, and the wind pressure will be taken up by horizontal steel-wire cables, placed under and connected to the floor.

The towers are entirely of wrought-iron, except the bases of the columns. A cross-section of one of the columns is shown in the engraving, four of which, 30 inches square each, are connected by lattice bars and form the tower. The chains are carried over the top of the tower on wrought-iron chairs or saddles, which are movable on rollers to allow for expansion and the elongation of the back chains under strain.

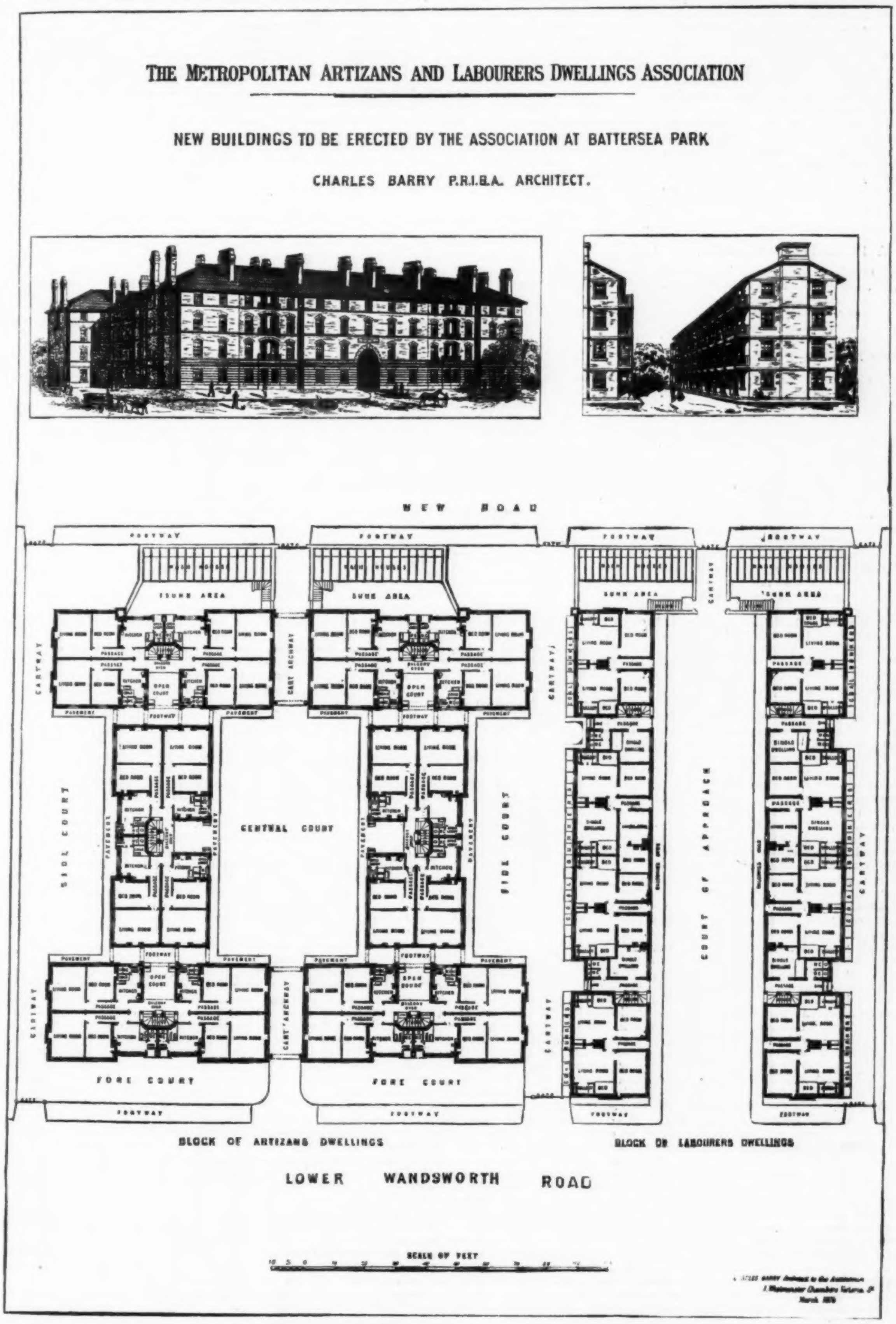
The bridge is proportioned for a moving load of 1600 lbs. per lineal foot, under which, together with the weight of structure, the chains will be strained to 12,000 lbs. per square inch, sectional area. The suspenders and roadway members are strained only from 8000 lbs. to 10,000 lbs. per square inch. The maximum compressive strains in the towers are 9000 lbs. per square inch. The bridge will be finished by the end of this year.—*Engineering News.*



POINT BRIDGE,
OVER THE MONONGAHELA RIVER, AT PITTSBURGH, PA.
THE AMERICAN BRIDGE CO., NEW YORK AND CHICAGO, ENGINEERS AND BUILDERS.

METROPOLITAN ARTISANS' AND LABORERS' DWELLINGS ASSOCIATION, LONDON.

WE illustrate the plans and general elevations of these new buildings. The association has been formed with the object of aiding and of giving practical effect in the metropolis to the act introduced last session for "facilitating the improvement of the dwellings of the working classes in large towns." The association is, as we can understand, to step in and carry out the provisions of the act where it cannot reconstruct, after removing offensive structures and clearing noxious sites. Another object of the association is to erect in convenient and healthy localities houses of a superior class suitable for respectable artisans. The plans we give show buildings in progress adjoining Battersea park, where a site of 2½ acres has been secured. These



consist of a block of self-contained dwellings, which contain 98 tenements of three and four rooms, and will house about 500 persons, and two other blocks of mixed dwellings containing 150 rooms, to be let as single two or three room tenements, and will house about 350 or 400 persons. The block for artisans is arranged, as will be seen, with a central court, with archway entrances, and the lengths of all the blocks are placed transversely between the Lower Wandsworth and the New Roads. The stairs are arranged on the balcony system, open on one side. The sitting rooms have an area of about 150 ft. each, and kitchens 60 ft., the rooms being 8 ft. high. The kitchens have sinks and water supply, coal-bins, cooking range, and copper, and open into balconies. A water-closet is provided for each tenement open to the air; the soil-pipes being carried through the roof as shafts. The staircases are of fire-proof materials. In the mixed dwellings the rooms vary in size, and are arranged to admit of being let as single rooms or in combinations of two or three. The water-closets in these blocks are approached from a transverse passage open at both ends, so that a current of air can circulate. The passages are accessible from the stairs, which are placed in recesses at the sides, thus insuring easy communication with every room, though complete separation from all dwelling rooms. Dust shoots are provided at side of staircase on each floor, delivering into dust pits. Windows are all double hung, and are close to ceilings. A sink and water supply are provided to the larger rooms. The views we illustrate will show the arrangement of galleries of communication along these blocks, which are four stories in height. The contractors are Messrs. Downs & Co., of Union Street, Borough, and the contract amount is £33,800. The buildings are expected to be finished in the spring of next year. Mr. Charles Barry is the architect, and we understand a site at Stroud Vale, near King's Cross, has been secured for other dwellings, upon which the larger portion of the capital of the association will be expended to meet the wants of the district.—*Building News.*

ONE OF THE CAUSES OF TYPHOID FEVER.

DR. WRIGHT states that in Cheltenham, England, he had attended many cases of typhoid fever, and upon investigation found they were all produced from imperfect drains. The construction of these works was generally left in the hands of jobbing men, who did not care how it was done; and he had himself seen men put down the pipes without attempting to make good the joints, thus allowing a leakage from the house drainage, and causing illness. In one instance he was called in to attend three children suffering from diphtheria, and on examining the place, he found there was a tube communicating with their bedroom which opened into the sink below close by the drain, which tube acted as a vent to bring up the effluvia into the bedroom.

Sir Henry Cole, K.C.B., states that he took a house which was certified to be in thorough repair, and perfectly fit for habitation; but he had not been there three weeks before he detected bad odors from the drains, and it took him six weeks to reform the whole of the internal drains. His neighbor not 200 yards off took a house, and after he had been there a short time, he found out the bad odors, and on sending for a responsible person to look into the matter, it was found that the drains, which were very good in themselves, had been imperfectly laid, the joints being put together with earth instead of cement. On asking the clerk of the works who came to examine them what he thought was saved by using earth instead of proper cement, he was informed that the saving would be 2*s*. a house. The clerk being asked whether he thought it worth while for the sake of 2*s*. to spoil a house which had cost £2000 or £3000, said "Consider the saving on a thousand houses." What a specimen of morality! The conclusion he drew from that was that they ought to insist in their various localities upon some certificate being given that the internal drains of the house were in proper order; for if a poor and ignorant man like himself took a house on the faith of what it ought to be, and got typhoid fever or diphtheria from imperfect drains, he had no redress.

DISCHARGE OF SEWAGE INTO THE SEA.

MR. ADAM SCOTT has said when decayed organic matter was discharged into fresh water, decomposition went on rapidly, by reason of the oxygen in the water, and putrefaction set in. But in salt water it was different; the salt acted as a kind of pickle, and thus those matters were found floating about for a long time, as had been stated. The result was that the atmosphere became charged with unhealthy gases, much in the same way as with gunpowder, ready to burst out on the slightest contact with a spark of disease. At Rio Janeiro, he understood that the sewage in former times was emptied into the sea, and seventy years ago that place was used as a sanatorium for the United States, but in consequence of this practice fever became so prevalent that ships refused to touch there if they could help it, and ten or twelve years ago the Rio Janeiro Improvement Company effected a deodorizing of all the houses, at a cost of £6 10s. per annum for each house. This reduced the yellow fever, and since then they had adopted water-carriage sewers, but unfortunately these emptied into the harbor, and the result was something exceedingly disgusting, and the effect on health very bad. In Naples, the sewage was discharged some distance from the town, and the same result took place. There was a most beautiful extent of sea-shore, which had become quite a scene of death; no one could reside there, and many noble villas were falling into utter ruin. Again, at Marseilles, for hundreds of years they had discharged the sewage into the sea, and the epidemics there were well known; in fact it had passed into a proverb in France that pilots could go into the harbor in the thickest fog, being guided by the smell alone.

CONCRETE AS A BUILDING MATERIAL.

AT an ordinary general meeting of the Royal Institute of British Architects, May, Mr. Charles Barry, the President, introduced the subject of the evening—the adjourned discussion of Mr. Alexander Payne's paper on "Concrete as a Building Material," intimating the author's desire that the speaker should take up the question of the artistic use of the material; in the former discussion the practical aspect of the matter had been dealt with.

Mr. J. P. Seddon, in the absence of Mr. Roger Smith, who had moved the adjournment of the discussion on the 15th May, opened the proceedings by explaining again how he had used concrete in building a large house in an out-of-the-way part of Ireland, where, although there was an abundance of good stone, no skilled workmen could be induced to stay to work it. The concrete was made on the spot, of the shingle and sand on the shore, and the house was built with 9-in. walls. Although it was an extremely wet climate, the house had been bone-dry inside, and no inconvenience was experienced from the use of sea-sand. It had since been decorated with mosaics on plaster (specimens of which were exhibited) by Rust and Salviati. The great defect which he found in concrete buildings was the facility with which sound was transmitted, especially through the floors, and he feared a house with both walls and floors of this material would be almost untenantable. Concrete should not, in his opinion, be used as pugging for this reason.

Mr. Lumsdon, a visitor from Aberdeenshire, said he had made an addition in concrete to the old castle in which he lived. The new portion was 51 ft. by 33 ft. and 20 ft. high, with a circular turret projecting from the first story. The walls were 9 in. thick, and had been built with Mr. Tall's appliances, for £350, little more than half the estimates given in previously by stone masons. This did not include the cost of "harling over," to resemble the ancient portions of the castle. Since then one of his men had learned the process in London, and had built cottages, etc., on his estate at from one third to one fourth less expense than mason's work would have been.

Mr. E. W. Tarn said his experience was rather against the use of concrete. He thought they ought to be careful how they regarded the prospectuses of patentees, as he had found considerable exaggeration in them. It had been stated that by the use of concrete, half the cost could be saved in construction, with ten times the strength of other materials; that it was impervious to wet and damp, and that, the walls being one solid mass, sound was completely deadened. He had had the pleasure of living in a concrete house he had built for himself, and would give his experience. First, as to cost. He built with 9 in. walls, and found that the chief cost of labor was for fixing and removing the patent appliances—that of filling in with the concrete itself was comparatively a mere nothing. Time was also lost in waiting for the weather. Again, he had to buy all his materials, including ballast; and this, in the neighborhood of London, was a serious item. As to strength, he found that, if well built, a concrete wall was about as strong as one in brick-work, but all depended on the proportion of cement used. As to its imperviousness, his walls, not having been laid with a damp course, continued to soak up the moisture, apparently by capillary attraction. He had lined the lower portions with tinfoil, but it still came through and destroyed the paper. On trying an experiment with a newly-laid floor, he found that water thrown down above, poured through it like a sieve, but that it was water-tight when rendered in cement. The roof had cracked over at regular intervals—he supposed, because of the different degrees of expansion of the concrete and the iron girders passing through and supporting it. Although rendered over again every winter, the concrete always cracked afresh. As to the passage of sound, he had been much annoyed by it, as noise was heard easily both through walls and floors. However, he thought the material valuable for use, where packed with rubble, when it could be built without scaffolding by means of shears for raising the stones, as in Yorkshire; it was also available in such places as Folkestone, or other seaside towns, where ballast could be obtained for almost nothing.

Mr. Edmeston thought the strength of concrete depended upon the materials used. Where ballast was at hand, buildings could be erected in it at one third the cost of brick-work. He had used it both on the sea-coast and on the banks of the Thames, and had never met any of the cracks alluded to by Mr. Tarn and speakers at previous meeting. He did not believe in the alleged contractibility of the material. In using concrete they did not want much apparatus. One application of concrete had not been mentioned by Mr. Payne, or any subsequent speaker. It was combined with asphalt for beds for steam-hammers, and was found the best material for resisting the blows.

Mr. Jennings thought it impossible to deal with the question of ornamenting concrete, except as a matter of cost. He should have liked to have heard something about the possibility and cost of carving concrete. It was stated that carving could be done more cheaply than in stone or brick. As a building material he had found concrete more expensive than brick-work. Its strength depended upon the proportion of Portland cement used, diminishing exactly in ratio with the amount of sand or ballast added. The shrinkage met with by Mr. Tarn must have been due to some mistake in using, probably from combining exposed surfaces of iron and concrete together.

Mr. Redgrave thought, if concrete was to be used extensively, it must be adopted in the form of stucco, which was a serious objection to the material. Sgraffito had been adopted at South Kensington and other places as a facing during the past few years, but an objection to it was that the two coats of concrete had little cohesion together, and the outer one pealed off, destroying the design. It also had the appearance, when used on a large scale, of covering a house with floor-cloth. He suggested that a simple mode of using concrete was to face it in panels with rough-cast, which could easily be set in zinc moulds.

Mr. Adams said he designed some houses which were built in concrete, under Mr. Drake's specifications, some eight or nine months since, and they had not a single crack in them. He had faced them in sgraffito, and the design—a simple scroll-work—was outlined by the artist at a cost of 2s. per superficial yard, and afterwards cut out by a laborer.

Mr. Cockerell, honorary secretary, believed that concrete walls would draw up damp, but considered that there was not much capillary action in the material; the more loosely it was packed the less would damp be able to rise in it. If well rendered in cement, rain would not drive through the wall. He had found that, in long pieces of wall, cracks occurred at regular intervals—doubtless resulting from shrinkage. In a garden wall built by himself, these cracks occurred at every 14 ft. or 15 ft.

Mr. Edmeston thought this might result from settlement or a variation in sub-soil.

Mr. Cockerell replied that there was in this instance no settlement, and if the cracks resulted from alterations in sub-soil, they would not occur at such regular intervals. He had noticed their occurrence at about the same distance in other long walls

Mr. Horace Jones: Then you consider that the non-contractibility of concrete is equal to about 14 ft. or 15 ft. in length?

Mr. Cockerell: Yes.

Mr. Aitchieson thought iron and concrete should be combined, unless the former were imbedded in the last-named material, and so preserved from the effects of changes of temperature. He suggested that the Institute should memorialize the Government to permit experiments in the use of small pieces of iron in concrete roofs (as suggested by Mr. Payne) to be made in the royal dockyards. It was very important that this combination should be tested. As to the ornamentation of concrete, he was surprised that greater use had not been made of pottery or tiles in facing these buildings, especially in large and smoky towns.

Mr. Cates explained the steps Mr. Penrose, as cathedral surveyor, had taken to protect the timber work between the outer and inner cupolas of St. Paul's from the risk of being set on fire. First dividing the work into sections, Mr. Penrose had isolated each of these, which included five bays of oak struts and stays of large scantling, into a separate compartment by means of concrete walls, in which were placed Broughton's patent stone-felt doors. Each timber was then encased in concrete, so that if a lighted match was thrown down by a visitor to the dome, it would burn harmlessly out. Mr. Penrose had proceeded on the assumption that the timber was well seasoned and perfectly dry. In a recent paper on the National Safe Company's premises, Mr. Whichcord had stated that he encased all iron-work and columns in terra cotta, to protect them from giving way under fire. He (Mr. Cates) believed that concrete was well adapted for use in this capacity, as it was fire-resisting and a non-conductor of heat.

Mr. Payne then rose to reply to the points raised in the discussions. He pointed out the marked contradictions in the opinions that had been given as to the usefulness, expensiveness, liability to shrink, and permeability to noise and damp of concrete, and suggested that those gentlemen objecting to its use should refer clients desirous of testing its merits to those who had pronounced in its favor. Since the first meeting a month since he had put a series of questions as to concrete to various builders, and he would briefly give the substance of the replies he had received. They agreed that there was no greater condensation on concrete surfaces than on those of brick and stone. As to contraction, he might say that all the speakers but one, who had referred to the cracking of concrete, had alluded to the old lime concrete, and not to that made of Portland cement. In Paris the sewers were generally made of concrete, and any failure from shrinkage would have been disastrous; but none had been announced. On our own lines many retaining walls of great length, as at Blackheath, for instance, had been constructed of this material, and he had failed to see a crack in them. He did not think there was any danger in combining iron and concrete. In large engineering works a thin skin of iron was used for piers (as at Charing Cross railway bridge), and filled with concrete; it was clear no appreciable contraction took place in these cases, as, if it did, failure must have resulted. As to relative cost, many patentees declared concrete could be built up at half the cost, or even less than that, of brick-work. His own experience showed that only a saving of about 10 per cent was to be looked for, and that without the hire of any complicated apparatus, but by simply using boards. Besides the cost, these patent appliances had the disadvantage of not being available where the plan was complicated, or for moulding projections. Before resuming his seat Mr. Payne exhibited a box he had designed for panel-work in concrete. The box was made the width of the wall, and showed on the face carved quatrefoil openings, in imitation of ancient wood-work; the concrete was poured into the box in the progress of the works, and filled it, showing at the interstices between the facing-boards.

The President said his opinion of concrete had been unaltered by the discussions; that while it was an excellent material when used under proper care and supervision, yet it afforded special facilities for neglect and misuse. He would caution the apostles of concrete building not to claim too much for it, as nothing was so likely to damage a new material in public estimation as exaggeration of its merits. The results of the discussions seemed to have been to bring out four points—1st, that concrete is peculiarly fit for use where the materials are at hand, and others are not. 2d, as to cost, they were still much in the dark; it seemed to depend upon the ease of procuring materials. 3d, that there was great need for supervision; and lastly, that the legitimate use of ornament was some superficial treatment. He trusted those using the material would endeavor to decorate it appropriately, and that a suitable mode of treatment would thus be developed. Before closing he must express the thanks of himself and those present to Mr. Payne for bringing forward one of the most interesting papers he had heard in that room.

FRENCH ACADEMY OF SCIENCES.

JULY.

On Fermentation of Urine. By MM. Pasteur and J. Joubert.—Human urine is normally acid, but it becomes alkaline when left quiet for several days. This alkalinity is due to the spontaneous formation of carbonate of ammonia at the expense of urea, one of the constant products of urine. The transformation has hitherto been referred to the phenomena of fermentation, of which it constitutes one of the most important examples. M. Musculus, a chemist of Strasbourg, has recently obtained from urine a matter precipitable by alcohol, but soluble in water, which transforms urea into carbonate of ammonia, very nearly as diastase changes starch into dextrine and into glucose. On this discovery, M. Musculus formulates the following conclusions: The ferment of urea has none of the properties which characterize organic ferments. On the contrary, it has much resemblance to the soluble ferments, such as diastase, saliva, and pancreatic juice. The conclusions reached by the authors of the present paper fail to agree with the above, and are as follow: Whenever urea or urine becomes ammoniacal, the presence and development of a microscopic organism occurs. Normal urine, when it does not contain the germ of this ferment, conserves its acidity indefinitely in contact with the air. It remains, however, to reconcile this with the facts noted by M. Musculus. The authors therefore consider that the soluble ferment observed by that chemist is produced by the small organic ferment of the urea. The maximum of production of the soluble ferment even coincides with the absence of urea in the urinary liquors, where the ferment is nourished and multiplies.

Observations on the Foregoing. By M. Berthelot.—This author notes the analogy of the above to views enunciated by himself in 1860, on the mode of formation and the rôle of glucosic ferment, soluble ferment, secreted by beer yeast, and which provokes hydratation and the desaggregation or spitting (*dédoublement*) of cane sugar. The living being is not the ferment, but simply engenders it. This essential distinction is of the greatest importance, and is fully confirmed by the researches of M. Pasteur.

Comments. By M. Pasteur.—Before my researches the agent of fermentation was considered as an albuminoid matter—that is, a dead substance, soluble or insoluble, which acted sometimes in one way (as by contact, as held by Berzelius, Mitscherlich, and others), and sometimes in another (as by communicated movement, a view sustained by Liebig). I have proved, first, that the agent is a microscopic organism; second, that this organism is not spontaneously generated, directly or indirectly.

On Electric Transmissions through the Soil. By M. du Moncel.—The author explains, First, the origin of telluric currents produced by the difference of humidity of soils in which the plates of communication of the circuit are buried. Second, the origin of those currents which are due to the unequal surface of these plates of communication, and to their more or less oxidized state. Third, the origin of currents of the same kind which arise under the same conditions with unattackable plates. Fourth, the considerable influence of these telluric currents on electric transmissions and their relative importance.

Among other interesting facts noted may be remarked the successive inversions of the current which is established when two well-cleaned zinc plates of unequal surface are kept plunged in distilled water. These inversions have been as numerous as nine within twenty-four hours. By assimilating the soil to its silex, M. du Moncel has rendered the latter suitable to produce currents analogous to telluric currents. For this purpose it has sufficed to form the electrodes of plates of different metals, or of the same metal differently oxidized. With plates of zinc and platinum, currents having an electro-motive force equivalent to one quarter of that of a Daniell element have been obtained, and which were indicated on the galvanometer as more intense and more constant than those of the Daniell element traversing the same stone. The resistance of the circuit 24,870 ohms was the same in the two cases. This peculiarity shows that in the first case the effects of galvanization are not produced but at the negative pole—that is to say, at the pole where the effects are the less pronounced; while in the second instance they are produced by both electrodes, which augments in an enormous proportion resistance to their passage and their injurious effects.

New Series of Observations on the Solar Spots and Protuberances. By Father Secchi.—These are the results of the author's observations for the last six months. It is well known that at present the sun presents its minimum activity. There have been very few protuberances, and scarcely any eruptions. As usual, the gas filaments arise in a straight vertical line. They last but for a brief period, and their connection with the faculæ remains the same. The escaping hydrogen seems to separate the darker envelope of absorbing metals, and thus to produce very small but well-defined faculæ, resembling brilliant grains. Since March, spots having nucleus and penumbra have been almost entirely absent. Small pores have occasionally appeared, but their duration has been brief. Such is the present appearance of the sun. It is remarkable that the most active regions occupy the latitudes comprised between $\pm$ 10° to 20°, and from 50° to 60°.

On Metallic Nickel from the Ores of New Caledonia. By MM. Christofle and Bouilhet. The ores received in Europe show the following composition: Water, 22; silex, 38; peroxide of iron, 7; protoxide of nickel, 18; magnesia, 15. The metal extracted is of excellent quality, and crushes under the hammer without breaking, a result hitherto not obtained by the authors, either with English nickel reduced in grains or German nickel in cubes. On analysis the metal titrates 98 per cent, and some samples have given as high as 99.5 per cent.

On the Manner of Employing Sulpho-Carbonates. By M. Joubert.—The destruction of the phylloxera by the sulphocarbonates is certain. The doses of the insecticide may, however, be reduced, since 145 grains per square yard give the same results as about four times the quantity. Three applications per year to attacked vines seem sufficient to complete a cure.

M. Mouillefert, in another note on the above subject, after carefully examining vines treated with the sulpho-carbonate of potassium last year, affirms that the sulpho carbonates protect the vine and even revive it after the most severe attacks of the malady.

On Astronomical Photography. By M. Cornu.—This relates to a new method of astronomical photography, which requires no special instrument. Any telescope (refracting) may be immediately adapted to photographic observations by the aid of a simple mechanical disposition, which in nowise alters the optical qualities of the instrument. It suffices to separate the two lenses which compose the objective for a distance depending on the nature of the glasses, but rarely exceeding 1½ per cent of the focal distance. This operation shortens the latter by about 6 or 8 per cent. Theory and experiment prove that

the premature achromatism of visible rays is transformed into achromatism of the chemical rays necessary to the perfection of photographic images. Direct and precise measurements have also shown that this slight separation of the glasses produces no aberration in the images. This method of achromatism has been adopted by the Transit of Venus Commission, and the results obtained have been very satisfactory. It has completely succeeded at the Paris Observatory, with the great equatorial of which the objective has 14.8 inches opening, and 28.4 feet focal distance. At the principal focus of the instrument direct photographic images of the sun and moon measuring nearly 3 inches in diameter were obtained. These without difficulty were amplified by the eye-piece so as to produce proofs of more than 3.2 feet in diameter.

PHYSICAL SOCIETY, LONDON.—JUNE.

Professor G. C. FOSTER, F.R.S., President, in the Chair.

EFFECT OF LENSES ON LIGHT.

Prof. GUTHRIE showed the action of Prof. Mach's apparatus for exhibiting to an audience the effect of lenses on a beam of light passed through them. It consists of a long rectangular box with glass sides, in which are several movable lenses. A parallel beam of light falls on a grating at one end of this box, and is thus split up into a number of small beams, which are rendered visible by filling the box with smoke. After passing through the first lens the rays fall on a movable white rod, which may be placed to indicate the focus. The light then falls on another lens partly covered with red and partly with blue glass, in order to more precisely exhibit the paths of the rays.

INTERESTING MAGNETIC RESEARCHES.

Baron WRANGELL exhibited the apparatus employed by Petrochovsky in his magnetic experiments. These experiments had reference to (1) normal magnetization; (2) the measurement of the distance of the poles of a magnet from its ends; and (3) a thermo-electric apparatus. The determinations were very much simplified by employing a unipolar magnetic needle formed by bending a small bar magnet at right angles at about a quarter of its length from one end. The needle is then suspended by a fibre attached to the end of the short arm, and the longer arm is maintained horizontal by a brass counterpoise weight. It will be evident that as one pole is in the axis of rotation it cannot have any effect on the motion of the needle. By turning up each end in this manner the moment of the magnet may be ascertained without knowing the exact positions of the poles. If a magnetic needle be so placed that a bar magnet parallel to it has no effect in deflecting it from the meridian, and the bar be then struck with a brass hammer, the state of equilibrium will be disturbed, as is shown by the motion of the needle. This, however, is not the case with a piece of soft iron round which an electric current is passing. The apparatus employed in the experiments on "normal magnetization" consisted of an arrangement for passing a current round rods of soft iron of varying lengths, so constructed that any number of the surrounding coils can be removed in the manner of an ordinary rheostat. After the current has been passed round the bar it is moved until its residual magnetism has no effect in deflecting a delicate unipolar needle from the meridian. The current is then passed round it, and the coils are adjusted until the magnetized bar has still no effect on the needle. The effect of the coils themselves is eliminated by means of a subsidiary coil. When the current is thus adjusted, the bar is said to be "normally" magnetized, and M. Petrochovsky has ascertained that this condition is satisfied when the length of the coil is 0.8 times that of the bar, and this is independent of the strength of current. This, then, is the only case in which the position of the poles is the same as when the bar is charged with residual magnetism. For the determination of the positions of the poles of a bar magnet a somewhat complicated apparatus was employed. A large unipolar magnet, about 8 inches in length, provided with a bifilar suspension, was enclosed in a glass box. A fine silver wire was stretched parallel to the axis of the needle between two projections on it, and it also carried a fine index at the horizontal end. The wire is focused in a telescope which can be made to travel along rails parallel to the magnet, and the index at the end can be observed by another telescope. A small magnet at right angles to the large magnet can be moved with the first telescope, and the point at which its effect in deflecting the unipolar is the greatest is ascertained by varying its position parallel to itself along a graduated scale, and then observing the space through which a subsidiary magnet must be moved in order to restore the unipolar to its initial position, as observed in the second telescope. When this point is reached it must be exactly opposite the pole of the large magnet. It was thus found that the poles are at a distance of one-tenth of the length of the magnet from its ends. To determine the position of the poles of a horseshoe magnet a delicate magnetic needle is placed below a fine wire in the meridian, and a horseshoe magnet is brought so that its two ends are immediately below the wire and near the needle. In the case of an electro-magnet the point at which its effect is greatest is found to vary when the coils are moved towards the ends, and is nearest to the ends when the coils project slightly beyond them. The third series of researches referred to was on the influence of an electric current on the thermo-electric action of soft iron. A number of strips of iron are connected by means of copper studs, and when currents are passed round the alternate strips it is found that the system acts as an ordinary thermo-pile. This question is, however, still under investigation. In reply to a question of the President, Baron WRANGELL stated that the effect of increasing the number of coils in the horseshoe magnet on the position of the poles is also still under investigation.

MAGNETIZATION OF COBALT AND NICKEL.

Prof. BARRETT then made a brief communication on the magnetization of cobalt and nickel. He has recently made some experiments on these metals with a view to ascertain whether they undergo any elongation or contraction similar to that experienced by iron during magnetization. From his first experiments he concluded that cobalt elongates slightly, but that there is no effect on nickel, but this latter result may have been due to the fact that the metal was not absolutely pure. He has, however, obtained through Mr. Gore a fine bar of pure nickel about two feet in length, and now finds that it contracts, and that the amount of this contraction is about the same as the expansion of a like iron bar when similarly treated.

CURIOUS DISCOVERY CONCERNING FREEZING OF COLLOIDS.

Prof. GUTHRIE then described some experiments on the freezing of aqueous solutions of colloid substances, which he has been studying in connection with his recent investigations on cryohydrates, etc. If a solution of sugar be gradually cooled the temperature at which ice separates out is always below 0° C., and the extent below increases with the amount of sugar in solution. But he finds that in a solution of gum, having exactly the same chemical formula, the ice always separates at 0° C. whatever be the amount of gum present. Thus, while every crystalline substance forms a freezing-mixture when mixed with ice or snow, colloids are incapable of doing so. The gum and the water do not recognize each other, and similar results were obtained in the case of gelatin and albumen. These facts are strictly in accordance with the results of Prof. Graham's classical researches. It almost follows that when heated similar effects are observed, and Prof. Guthrie has found that solutions of gum in varying proportions always boil at 100° C.

Mr. W. CHANDLER ROBERTS said that this important discovery was one that his late distinguished master would have welcomed, and he expressed a hope that Dr. Guthrie would continue his experiments with the series of colloids actually prepared by Graham.

DEPOLARIZING EFFECTS OF GLASS, RESIN, ETC.

Prof. GUTHRIE then showed the experiment by which Dr. Kerr has recently proved that glass, resin, and certain other substances exhibit a depolarizing effect when under the influence of a powerful electrical tension. With the help of Mr. Lodge, Dr. Guthrie has succeeded in repeating these exceedingly delicate observations, but the effect is very slight, and ill suited for the lecture-room. A beam of polarized light traverses a thick plate of glass in which two holes have been drilled, nearly meeting in the centre, and two wires are fixed in these, and connected with the terminals of a powerful coil. The light after passing through the analyzer falls on the screen. If now the analyzer be so turned that the illumination is least before the current is turned on, the brightness of the field will be seen to increase as soon as the circuit is closed, and this brightness will gradually increase up to a certain limit. The effect is greatest when the light is polarized at an angle of 45° to the line joining the terminals.

The PRESIDENT then adjourned the meetings of the Society until November.—*Chemical News.*

THE CHEMICAL SOCIETY, LONDON.—JUNE.

Professor GLADSTONE, F.R.S., Vice-President, in the Chair.

THE names of the visitors having been announced, and the minutes of the previous meeting confirmed, the names of Messrs. E. H. W. Swete and C. Law were read for the first time. Messrs. Arthur Brownhill Cortis, George F. Thomson, John Heron, Charles George Matthews, George Evans, and Dr. Otto N. Witt were balloted for and elected after their names had been read for the third time.

VACUUM BY ABSORPTION.

The first communication, "Chemical Studies," was given by Professor Dewar. The first note was on a method of producing a vacuum by the absorption of gases or vapors. In one instance he had tried to remove the residual hydrogen by palladium, but as the tension of hydrogen-palladium at the ordinary temperature is two or three millimetres, it was evidently inapplicable. He had met with better success by using bromine, and absorbing the residual vapor by means of carbon; it was merely necessary to boil off a small quantity of bromine in a tube so as to expel the air, seal it and allow it to cool; the carbon, which is confined to a small portion of the tube by a construction, then absorbs the residual vapor so completely that the electric discharge gives very broad striæ, which are symmetrical at the two poles—a sign of a very good vacuum. It is curious that at ordinary temperatures, the spectrum of the discharge gives no bromine lines, but only carbon lines due to a trace of carbonic anhydride. When the carbon is heated, however, the bromine lines make their appearance. Chlorine and carbon bisulphide may also be employed with carbon. The author had found the perfection of the vacuum proportional to the heat developed by the absorption of the vapor by the carbon. He also exhibited some exhausted tubes containing phosphorus which had been partly exposed to the light. Here the phosphorus vapors had condensed and crystallized on the glass in the polymerized state. After some remarks on the latent heat of dissociation of ammonium carbamate, which he had found by experiment to correspond very closely to that required by the dynamical theory of heat, he described a method by which he had determined the latent heat of the formation of ozone from oxygen; this was done by passing it through a solution of hydriodic acid, observing the heat developed, and making a correction for that due to the decomposition of the hydriodic acid. It was found to be between 5000 and 6000 units.

REDUCTION OF NITRIC ACID.

Dr. Armstrong gave a short account of his "Researches on the reduction of Nitric Acid, and on the Oxides of Nitrogen, Part I., on the Gas evolved by the action of Metals on Nitric Acid," made in conjunction with Mr. Acworth. After referring to the statements in the texts books, and reading extracts from Odling and from Gmelin, as representing the present state of our knowledge of the subject, which was very imperfect from the fact that the experimenters had merely considered the qualitative composition of the gas, and not the relation of the amount of gas to the metal taken, he stated that it was now universally admitted that the first action of the metal on nitric acid was that represented by the equation $R'' + 2HNO_3 = H_2 + R'' N_2 O_6$, and that the hydrogen at the moment of its liberation acted on the excess of nitric acid, producing either nitric or nitrous oxide, or free nitrogen. The theoretical amount of gas per unit of metal R'' dissolved being 14,920 c.c. for NO; 5595 for N_2O; and 4475 for N. The method of experimenting adopted consisted in dissolving a known weight of the metal in excess of acid in vacuo, carefully collecting the evolved gas by means of a Sprengel pump, and then measuring it. The results were exhibited in a series of tables showing the temperature, strength of acid, total amount of gas, percentage of NO, N_2O and N, also the cub. centims. of gas per unit of metal, which never exceeds that required by theory. With copper the amount of NO is comparatively large, although the presence of cupric nitrate in large quantity exerts a considerable influence on the result, increasing the amount of nitrous oxide. With zinc, the N_2O obtained is comparatively large, and as with copper, the presence of much zincic nitrate increases it. In the case of cadmium and magnesium, the former yields less N_2O than zinc, whilst the latter gives more, showing that cadmium is less active and magnesium more active than zinc. Tin yields chiefly N_2O. Nickel differs totally from iron in its action on the acid, the result being chiefly N_2O with the latter, NO with the former. It was found that chemically pure nickel obtained by reduction in a current of hydrogen gave off hydrogen when dissolved in nitric acid; this was, most probably, occluded hydrogen. Silver, lead and thallium were also tried. The authors especially call attention to the fact, clearly shown by these results, that the hydrogen molecule differs greatly in its action on the excess of nitric acid according to the metal by which it is liberated.

NEW ALKALOID.

Mr. C. T. Kingzett read a paper "On an Alkaloid obtained from Jaborandi, its Platinic Compound, and their Formulæ." The alkaloid was obtained from the aqueous extract of the plant by precipitation with phosphomolybdic acid and the precipitate decomposed by baryta, or the extract was concentrated by evaporation, mixed with alcohol, to throw down albuminous matters, etc., and after treatment with ether and ammonia, extracted with chloroform. Although no crystalline hydrochloride of the alkaloid could be obtained, the platinic compound forms distinct reddish-yellow octohedral crystals of the formula $C_{22}H_{34}N_4O_4$, 2HCl, $PtCl_4$.

ACTION OF IODINE AND ALUMINIUM ON ETHER.

The Chairman having thanked the authors, gave a short abstract of a paper by himself and Mr. A. Tribe, "On the Simultaneous Action of Iodine and Aluminium on Ether and Compound Ethers." The authors find that although ether is not affected when boiled with aluminium and aluminic iodide, yet, when treated simultaneously with iodine and aluminium, a powerful action takes place, the products being ethylic iodide and aluminic iodoethylate:

$$3(C_2H_5)_2O + Al_2I_6 = 3C_2H_5I + Al_2I_3(C_2H_5O)_3.$$

The iodoethylate may readily be obtained in a state of comparative purity by treating alcohol with aluminic iodide and aluminium, as shown in the equation:

$$6C_2H_5O.H + Al_2I_6 + Al_2 = 2Al_2I_3(C_2H_5O)_3 + H_6.$$

It is a brown non-crystalline substance. The authors have also examined the action of iodine and aluminium on ethylic and amylic acetate, and find that the products are ethylic and amylic iodide and aluminic acetate, the reaction being

$$6C_nH_{2n+1}, C_2H_3O_2 + Al_2 + I_6 = 6C_nH_{2n+1}I + Al_2(C_2H_3O_2)_6.$$

ANTIMONY PENTACHLORIDE AND ALCOHOLS.

The next paper was "On some Compounds of Antimony Pentachlori e with Alcohols and with Ether," by Mr. W. Carleton Williams. In order to prepare these compounds the pentachloride is cautiously mixed with the alcohol, taking care to avoid rise of temperature, and the product purified by crystallization from alcohol or ether. They are hygroscopic, readily soluble in alcohol or ether, and are decomposed by distillation or by the action of water. The methyl alcoholate $SbCl_5$, CH_4O, forms pale yellow plates, melting at 81 deg. Cent.; the ethyl alcoholate $SbCl_5$, C_2H_6O, crystallizes in long colorless needles, which fuse at 66 deg. Cent.; the amyl alcoholate is also a white crystallic body, whilst the ether compound $SbCl_5$, $C_4H_{10}O$, exists as a finely divided grayish-white crystalline powder, which melts at 68 deg. Cent., and decomposes slowly at the ordinary temperature, and rapidly at 70 deg. Cent.

VOLATILITY OF BARIUM, ETC.

A paper by Professor J. W. Mallett, "On the Volatility of Barium, Strontium, and Calcium," was then read. The author has ascertained by a series of carefully made experiments that when lime, baryta, or strontia is heated in contact with metallic aluminium to a very high temperature in a carbon crucible, it suffers an appreciable loss of weight—in some instances to the extent of more than 3 per cent—indicating that the alkaline earth must have been partly reduced and the metal volatilized. This supposition is confirmed by the observation of the flame of the carbon monoxide which is given off, the characteristic lines of the metal being distinctly visible when it is examined with the spectroscope.

The next communication was on the

ACTION OF CHLORINE ON ACETAMIDE,

by Dr. E. W. Prevost. It gives rise to two substances, one of which melts at 68 deg. Cent., and the other at 129.5 deg. Cent. They both crystallize in colorless needles, but the author was not able to deduce any satisfactory formula from the analytical results.

NOTE ON THE PERBROMATES.

Mr. M. M. P. Muir corrected his former statement that perbromic acid may be easily prepared by the action of bromine on an aqueous solution of perchloric acid (Kämmerer's process), his subsequent attempts to prepare perbromic acid in this manner having been invariably unsuccessful.

The last paper was by Dr. J. G. Blackley, on a

NEW AND CONVENIENT FORM OF UREOMETER.

In it he gives a description of a simple form of apparatus analogous to Russell and West's ureometer, which is exceedingly convenient for clinical purposes, the method consisting in measuring the amount of nitrogen evolved on decomposing urea by sodium hypobromite. After making the correction pointed out by Russell and West, the experiments made with a view of testing the apparatus gave very concordant and satisfactory results.

IODINE AS AN IMPURITY IN NITRIC ACID.

MR. FRIEDBURG having stated in a paper read before the German Chemical Society that, on treating carbon disulphide with fuming nitric acid, he had observed the former to assume a rose-red or violet color, which he ascribed to some impurity in the CS_2, Mr. P. Marquart replies that commercial nitric acid nearly always contains iodine, which may easily be shown by subjecting it to distillation to dryness. During the end of the process violet vapors are frequently given off, and handsome crystals of iodine are found in the neck of the retort on cooling.

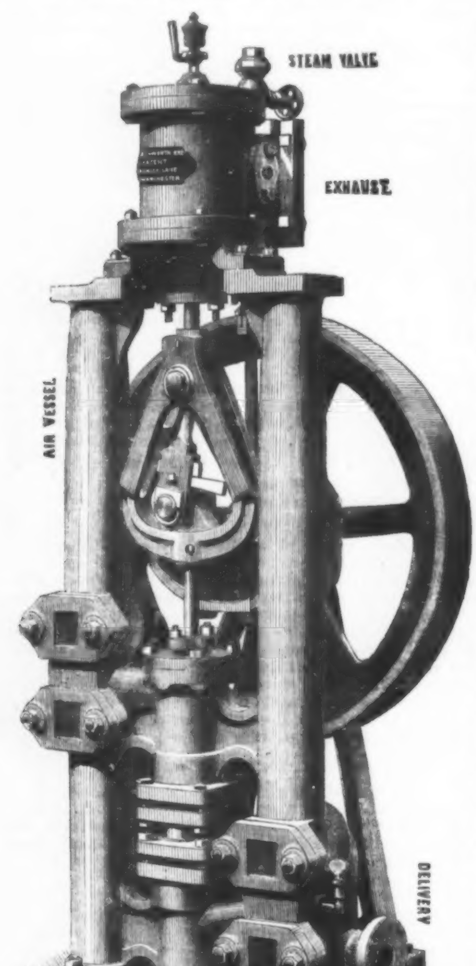
In order to convince himself whether the coloration of carbon disulphide, when treated in the above-mentioned manner, was really owing to the presence of iodine, Mr. Marquart agitated a sample of fuming nitric acid chosen at random, with carbon disulphide, added water, and found the CS_2 colored rose-red. Treated with water and dilute sulphurous acid it lost its color, and the aqueous solution gave the usual reactions for iodine with starch and palladium nitrate. A specially prepared acid, known to be free from iodine, when shaken with carbon disulphide imparted no color to the latter whatever.

When searching for iodine in this manner it is immaterial whether the water be added to the previously separated carbon disulphide or to the mixture of the two substances. If iodine is present the color appears invariably, and at once.

ASHWORTH'S DOUBLE-ACTING STEAM-PUMP.

One of the obstacles to the general introduction of the single-acting plunger pump consisted in the comparatively small quantity of water that could be drawn by the same. Frequent attempts have therefore been made, in the most varying forms and applications, to produce a successful double-acting plunger pump. One of the latest constructions in this line is the double acting pump of Ashworth, which is shown in the accompanying illustration. The base plate of the same is cast hollow, to serve as a reservoir for the water drawn in through the suction pipe. The two pump cylinders are arranged one above the other, and centrally between upright air pillars, with which they form one casting. This method of casting the pump cylinders, it is claimed by the manufacturer, has the advantage of providing perfect concentricity of the interior surfaces of the pump cylinders with that of the steam cylinder on the top of the pillars. The entire casting is for this purpose placed on the boring machine, and the pump cylinders, simultaneously with the seats of the steam cylinder on the air pillars, turned out, so that the concentricity of the surfaces is accurately obtained. This, however, might be rendered nugatory by any inaccurate mounting of the steam cylinder, and it seems as if the object in view might be reached in a more certain manner by boring the steam cylinder jointly with the pump cylinders.

The plunger pistons are packed in the customary manner, and worked by the steam piston in connection with a transmitting sector. The air pillars are hollow, and connected with each of the pump cylinders by two valves.



ASHWORTH'S DOUBLE-ACTING STEAM-PUMP.

The pump operates in the following manner:

The upward stroke of the pistons forces the water from the upper pump cylinders, first in the space between the two valves of the air pillar communicating with the upper pump cylinder, closing thereby the lower and opening the upper valve, so that the water enters the upper part of the pillar. The air above the same is thereby compressed, and serves to exert a pressure on the water, which is then forced to and discharged through the delivery pipe. Simultaneously with the action of the upper pump cylinder a vacuum is created in the lower cylinder, which opens the lower valve of the other air pillar, and admits thereby the free entrance of water from the base reservoir. The downward stroke of the pistons forces the water in similar manner as before from the lower pump cylinder into the space between the valves of the air pillar connecting therewith, and then into the upper part of the same, from which it is conducted to the discharge pipe, while at the same time a vacuum in the upper cylinder opens the lower valve of its air pillar and draws in the water from the base reservoir, and so on alternately with the up and down strokes of the pistons.

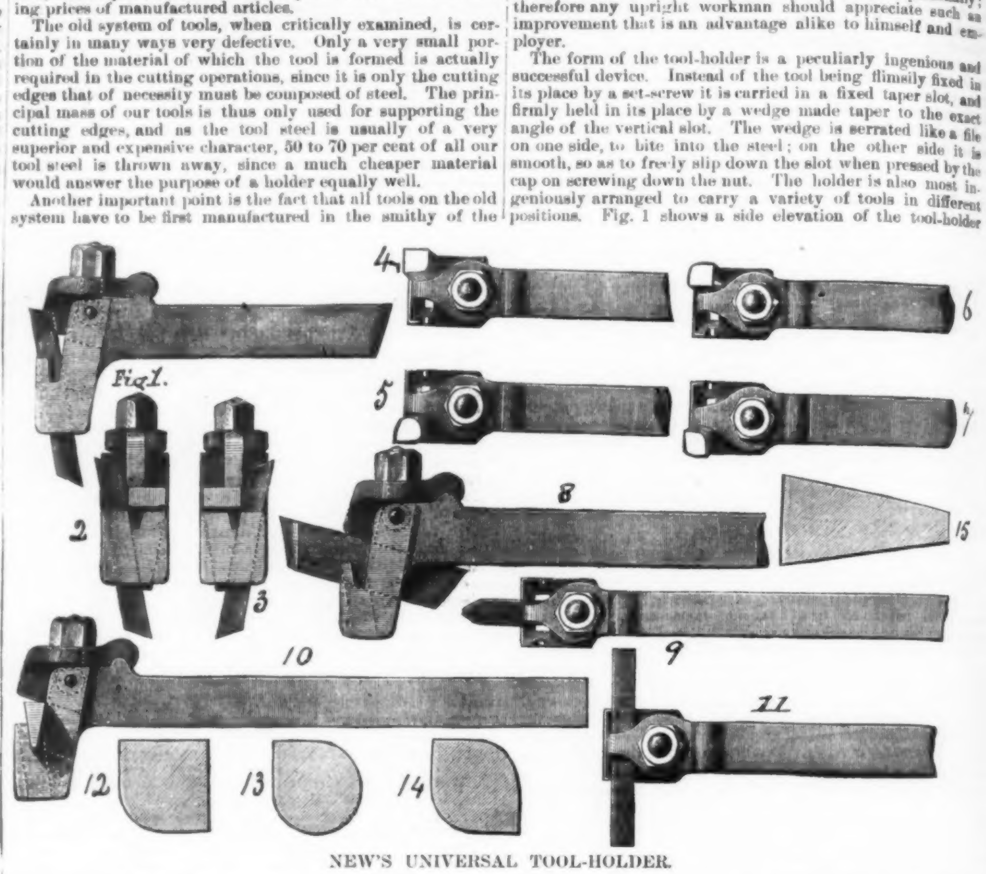
NEW'S UNIVERSAL TOOL-HOLDER.

So small a matter as the angle at which tools are ground very materially affects their cutting power, and in consequence their capabilities of turning out work.

So close now is competition driving our manufacturers, that the question of being able to turn out 10 or 15 per cent more work from any tool or machine, is well worth their consideration, and may be of sufficient consequence to reduce their selling prices of manufactured articles.

The old system of tools, when critically examined, is certainly in many ways very defective. Only a very small portion of the material of which the tool is formed is actually required in the cutting operations, since it is only the cutting edges that of necessity must be composed of steel. The principal mass of our tools is thus only used for supporting the cutting edges, and as the tool steel is usually of a very superior and expensive character, 50 to 70 per cent of all our tool steel is thrown away, since a much cheaper material would answer the purpose of a holder equally well.

Another important point is the fact that all tools on the old system have to be first manufactured in the smithy of the tool user before it is fit for use, and this working at the forge must be often repeated as the tool wears down, since a very slight amount of wear upon the cutting face will have worn down the tool to such an extent as to make reforging a necessity.



NEW'S UNIVERSAL TOOL-HOLDER.

Messrs. D. New & Co., of Nottingham, England, have very ably taken this question of tool waste in hand, and their patent tool-holders and cutting tools, which we illustrate, have, as far as we can see, entirely solved the question in a highly practical and effective manner.

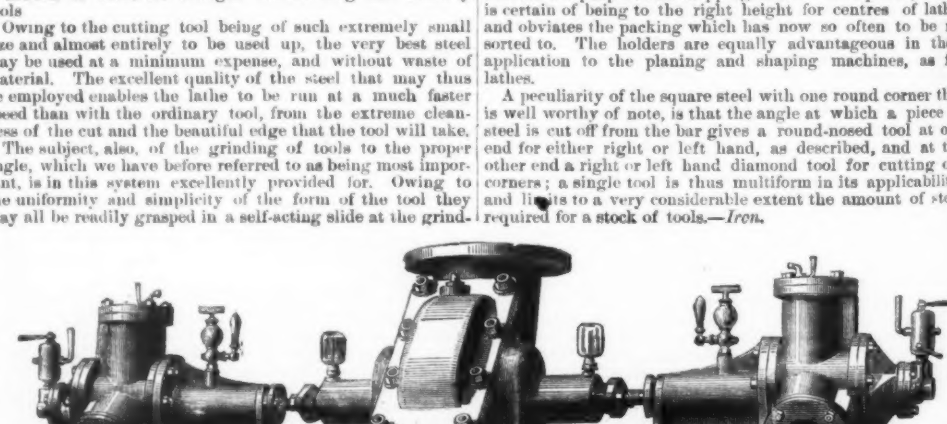
The holder is in this system entirely distinct from the cutting tool, and may be thus best made of mild cast-steel of inferior value to the material used for cutting tools, whilst the tool may be made of the best tempered steel. A uniform shape, also, of tool may be always employed and may be supplied of such simple sections that no further forging is required. Ordinary round or square steel may thus be used for the cutting tools, but some special sections shown in Figs. 12, 13, and 14—square, with one round corner, or single and double Veed rounds—are most recommended. Fig. 15 shows a section of steel for straight cross-cutting and ordinary tools

Owing to the cutting tool being of such extremely small size and almost entirely to be used up, the very best steel may be used at a minimum expense, and without waste of material. The excellent quality of the steel that may thus be employed enables the lathe to be run at a much faster speed than with the ordinary tool, from the extreme cleanness of the cut and the beautiful edge that the tool will take.

The subject, also, of the grinding of tools to the proper angle, which we have before referred to as being most important, is in this system excellently provided for. Owing to the uniformity and simplicity of the form of the tool they may all be readily grasped in a self-acting slide at the grindstone, which thus ensures that the tools are all systematically ground to the best possible angle for the different metals. A very great cause of loss of time to machine hands is occasioned by their having to leave their machine to grind their tools at the grindstone. In this system, with a self-acting angle slide, the grinding may be done by a boy or laborer, whose special duty it is to collect the blunted tools and supply sharpened ones in their place. The saving of time to the machine hands in this arrangement can be only appreciated by those who have actually seen the time wasted in waiting for the turn at a grindstone, the time too required to grind, the time lost in chatting to the smith whilst he repairs the tool, and, in fine, the numerous occasions for talking and dawdling about, that attention to the reforging and grinding of tools at present necessitates. Taking a more favorable view, it is evidently more convenient to an industrious workman to work with these tools, which he can always have ready for use with so little trouble to himself personally; therefore any upright workman should appreciate such an improvement that is an advantage alike to himself and employer.

The form of the tool-holder is a peculiarly ingenious and successful device. Instead of the tool being flimsily fixed in its place by a set-screw it is carried in a fixed taper slot, and firmly held in its place by a wedge made taper to the exact angle of the vertical slot. The wedge is serrated like a file on one side, to bite into the steel; on the other side it is smooth, so as to freely slip down the slot when pressed by the cap on screwing down the nut. The holder is also most ingeniously arranged to carry a variety of tools in different positions. Fig. 1 shows a side elevation of the tool-holder with a tool firmly grasped. Figs. 2 and 3 show the end elevation of the holder grasping respectively a right and left handed tool. The different arrangements are produced by simply shifting over the cutting tool to the left or right hand side of the vertical slot, and at the same time changing the position of the wedge to the alternate side. Figs. 4 and 5 show a plan of the way in which a square-nosed or "cornering" tool would be held. Figs. 6 and 7 show position of a round-nosed or "sliding" tool. Figs. 8 and 9 show position of a straight tool used for screw-cutting. It lies in a parallel slot firmly held by the cap pressed down by the nut and bolt. No wedge is required in this case. Figs. 10 and 11 show an elevation and plan of the manner in which a tool for undercutting at right angles, on either left or right side, is held in an equally secure manner to the straight tool. The holder is thus universal in its capabilities of being used for any class of tool or description of work, as a variety of shaped tools can be formed out of the flat V section of straight-tool. The tools may be easily shifted or changed for various operations by only slacking a single nut placed in most convenient position for the purpose and dropping in the tool required, which is certain of being to the right height for centres of lathe, and obviates the packing which has now so often to be resorted to. The holders are equally advantageous in their application to the planing and shaping machines, as for lathes.

A peculiarity of the square steel with one round corner that is well worthy of note, is that the angle at which a piece of steel is cut off from the bar gives a round-nosed tool at one end for either right or left hand, as described, and at the other end a right or left hand diamond tool for cutting out corners; a single tool is thus multiform in its applicability, and limits to a very considerable extent the amount of steel required for a stock of tools.—*Iron.*



CENTRIFUGAL PUMP AND THREE-CYLINDER ENGINE.

CENTRIFUGAL PUMP AND THREE-CYLINDER ENGINE.

We give an engraving showing a centrifugal pump driven by a pair of Mr. Brotherhood's well-known three-cylinder engines. The pump is of the Appold type, with a disc 14 in. in diameter, and it is intended to deliver 800 gallons per minute on a 35 ft. lift, the speed being 800 revolutions direct. The engines, as will be seen, drive the pump direct, there being two engines connected one to each end of the pump spindle. The engines have cylinders 4 in. in diameter with 3 in. stroke. The employment of two engines in this way equalizes the strain on the pump spindle, and it is found, moreover, that for such very high speeds the use of small engines is preferable. The whole arrangement is very nearly worked out.—*Engineering.*

ZINC BATH FOR GALVANIZING IRON WIRE.

IT is known to iron galvanizers that in their trade a far greater part of zinc is spoiled than is really used for covering the iron. On the bottom of the bath of zinc or spelter, in which the iron articles are immersed, a half-melted mass appears, increasing in bulk and absorbing eventually all liquid metal. This substance, termed "dross" or "hard metal," is chiefly a combination of zinc and iron, in which the amount of the latter rarely exceeds 5 per cent. It requires a considerably higher temperature to melt it than pure zinc, in a

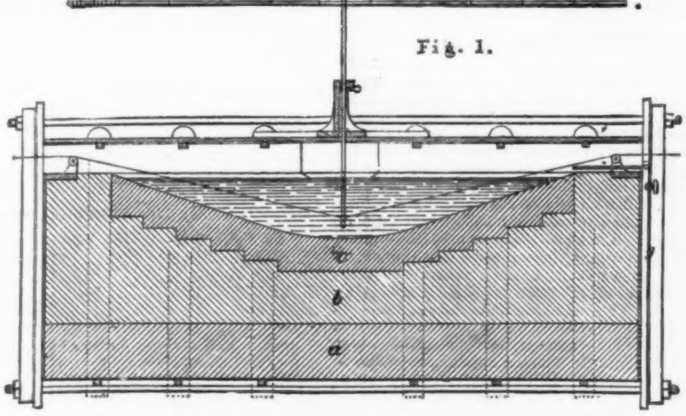


Fig. 1.

bath of which, therefore, it sinks down on account of its greater density.

The formation of this dross is of course partly due to the decomposition of the chloride of iron adhering to the articles after their immersion in hydrochloric acid; still the much greater part undoubtedly originates from the direct action of the iron reservoirs in which the zinc is usually melted and kept in the liquid state. It cannot be avoided that such iron vessels, at the places where they are exposed to the fire, get over-heated, even red hot, and this is chiefly the cause of the combination of the two metals, which takes place the more

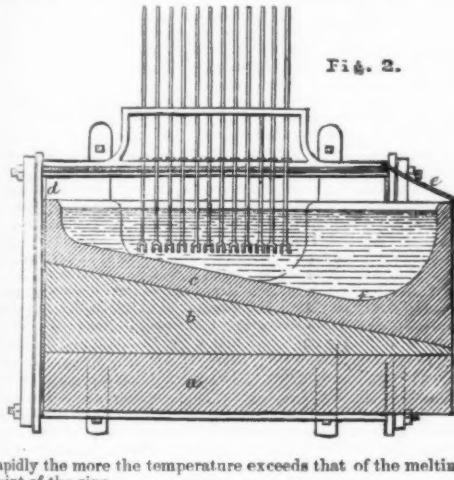
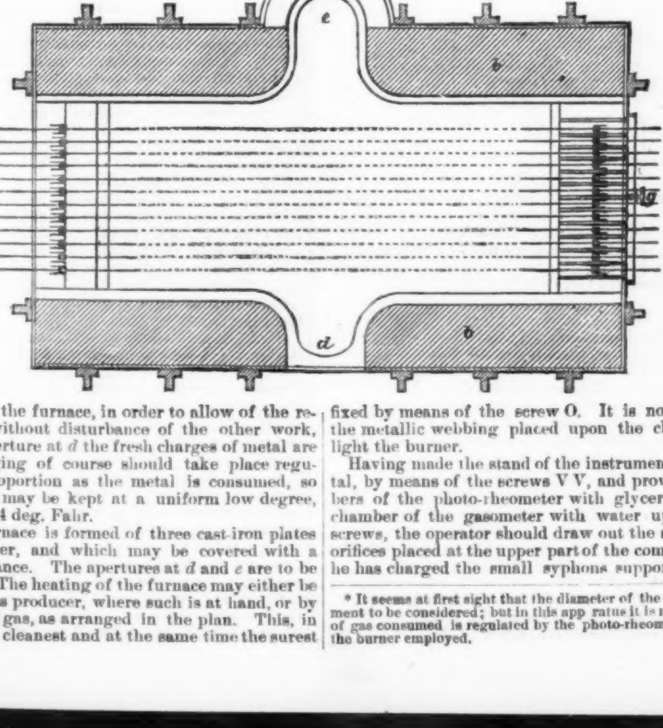


Fig. 2.

rapidly the more the temperature exceeds that of the melting point of the zinc.

Acting on the opinion that at least half of the dross produced in the galvanizing works may safely be set to the account of the iron taken up by the zinc from the vessels in which the bath is kept, Mr. F. A. Thum, of the Tindall Spelter Works, at Milton, near Carlisle, has endeavored to construct a bath in the form of a reverberatory furnace heated with gas, as shown in the accompanying engraving. In this arrangement *a* is the foundation, consisting of a stone wall, *b* brickwork, *c* is the floor stamped together of finely ground and moistened fireclay, in the same manner as it is done for the bath furnaces of the zinc rolling mills. Towards *f* the floor inclines and forms a well, which projects to some extent

Fig. 3.



over the side wall of the furnace, in order to allow of the removal of the dross without disturbance of the other work, whilst through an aperture at *d* the fresh charges of metal are given in. The charging of course should take place regularly in the same proportion as the metal is consumed, so that the temperature may be kept at a uniform low degree, say 440 deg. C., or 824 deg. Fahr.

The roof of the furnace is formed of three cast-iron plates overlapping each other, and which may be covered with a non-conducting substance. The apertures at *d* and *e* are to be provided with doors. The heating of the furnace may either be done by gas from a gas producer, where such is at hand, or by common illuminating gas, as arranged in the plan. This, in any case, will be the cleanest and at the same time the surest mode of regulating the heat to the exact degree required. In the arrangement shown in the plan, the gas is supplied through a main tube *g*, provided with a cock and breaking out into 13 burners, one at each side of a wire, so that the latter at the same time will be dried and partly heated before they enter the bath. Taking as a maximum the consumption of each burner at 15 cubic feet per hour, the necessary gas will be 4680 cubic feet in twenty-four hours, representing about 20s. to 25s. in value, which Mr. Thum considers not out of the way, if it is considered that half of the usual dross may be avoided in that manner, that the galvanizing work may be carried on without interruption, and that the apparatus will require very little or no repair. The only difficulty appears to be the introduction of new wires into the bath; however, this may be easily managed by means of a proper tool for the purpose.—*Engineering.*

M. GIROUD'S "GAS VERIFIER."

AN easy and sufficiently exact estimation of the quality of gas, as far as regards its illuminating power, has become a matter of primary importance.

M. Giroud's "Verifier" not only gives ordinarily correct indications, but takes account of the two elements to be considered, enabling gas managers to ascertain the quality of their gas in a very exact and simple manner by fixing the height of the flame, and by ascertaining the consumption necessary to obtain that flame. We have ascertained by numerous experiments, that with the standard gas of Paris, an expenditure of 38 litres (1.35 cubic feet) per hour gives, with a candle-burner having a hole about a millimètre in capacity,* a flame 105 millimètres (4 inches) in height, which corresponds to the light of one candle. That is the standard of unity adopted for the "Verifier." The gas will, therefore, conform to the Paris standard whenever this expenditure of 38 litres takes place, it will be below that quality when the expenditure is more than 38 litres, and above it when less than that quantity is consumed.

Description of the "Verifier."—The apparatus is composed of a photo-rheometer, regulated to a consumption of 38 litres of gas of the Paris standard, and of a gasometer intended for measuring the quantity of gas consumed by the photo-rheometer in the space of one minute, when, with a candle-burner having an orifice of about one millimètre, a flame 105 millimètres in height is produced. The gasometer is balanced by a counterweight P, so that it may rise under a pressure of from 10 to 15 millimètres (4-10ths to 6-10ths), and by compensators, C C, which maintain constant the weight of the immersed portion of the gasometer, and at the same time insure the invariability of the water-level in all positions of immersion. The weight P carries a horizontal needle sliding upon a scale graduated in millimètres, and attached to a ratchet bar actuated by the button D.

It is advisable to leave the jet of the photo-rheometer always burning, so that the apparatus may be ready for action without the danger of a small quantity of air becoming mixed with the gas. The flame is protected by a glass chimney, partially blackened on the inner side, in order to avoid reflection; it has two lines marked upon it, at the distance of 105 millimètres from each other. The lower line should be brought to the level of the orifice of the burner by raising or lowering the gallery which supports the chimney. This gallery is then fixed by means of the screw O. It is not necessary to raise the metallic webbing placed upon the chimney, in order to light the burner.

Having made the stand of the instrument perfectly horizontal, by means of the screws V V, and provided the two chambers of the photo-rheometer with glycerine, and the lower chamber of the gasometer with water up to the levelling-screws, the operator should draw out the air by means of the orifices placed at the upper part of the compensators C C, until he has charged the small syphons supporting these compensators. This operation has to be repeated each time the gas-holder is taken entirely out of water. The apparatus is then ready for action.

The gas enters at L, and passes on to be consumed at the burner so long as the stop-cock B is in the position indicated in the engraving; but when the handle is turned to an angle of 90 degrees in the direction of the pipe communicating with the gasometer, the gas gauged by the photo-rheometer passes into the gasometer instead of burning at the jet.

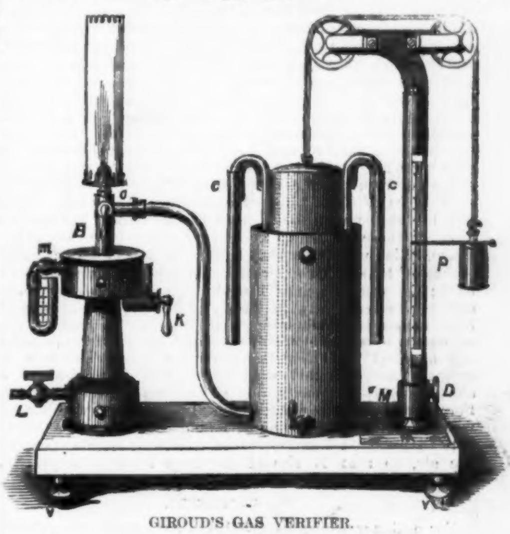
Method of Conducting an Experiment.—In order to test a gas, the operator should first light the burner, and then notice whether the flame is 105 millimètres in height: if higher than that it should be reduced by closing the stop-cock L; if lower, it should be increased by opening the stop-cock K. The requisite height having been obtained, a small quantity of gas is passed into the gasometer to float it, by raising the handle B horizontally to the right, restoring it to its original position as soon as the gasometer has risen about a centimètre. The zero point on the scale should then be brought under the needle by means of the button D, and the apparatus is ready.

All that is required now is, to send the gas into the gasometer by turning the handle B quickly with one hand, and at precisely the same moment starting a minute-clock with the other. At the expiration of one minute the handle B should be sharply restored to its original position. It now only remains to read off the division on the scale at the point where the needle P has stopped, which indicates the height to which the gasometer has risen. If the needle indicates 127 millimètres (5 inches), the gas is equal to the standard gas of Paris; if less than 127 millimètres, it is of better quality; if more, it is of inferior quality.*

R is a stop-cock for emptying the gasometer after each experiment; M is another for emptying the water-chamber. The stop-cock *m* in the manometer should always be left closed.

Before commencing an experiment the operator should satisfy himself that the pressure of the gas entering at L is at least 30 millimètres (12-10ths).

All the foregoing remarks refer to the standard gas of Paris, which, when burned at the rate of 105 litres (3.7 cubic feet) per hour, gives a light of 7½ candles. But if, owing to the conditions of some contract, the same illuminating power has to be obtained in certain localities, with a different quantity of gas, the expenditure of this gas, corresponding to one candle, or to the flame of 105 millimètres of the apparatus, would be obtained by multiplying by 38 the number of litres



GIROUD'S GAS VERIFIER.

stipulated for, and dividing the product by 105. As a movement to the extent of 127 millimètres by the gasometer corresponds to 38 litres, it is easy to ascertain the number of millimètres the gasometer should rise for the quality of gas prescribed in this case.

The following example will show the method of deducing from one observation the illuminating power of a gas. Let us suppose that the operations have been carried out as previously indicated, and that the gasometer has risen to 124 millimètres. We know that 127 millimètres correspond to 38 litres consumption per hour at the burner; one millimètre will therefore correspond to 38 ÷ 127, and 124 millimètres to 124 × 38 ÷ 127, which works out to a consumption of 37.1 litres. If 127 millimètres were not the number corresponding to 38 litres, it would be necessary to substitute for it, in the preceding calculation, the number marked for each apparatus.

It will be seen that the foregoing calculation is only an investigation into the actual capacity of the gasometer, and serves to establish the table of consumption corresponding to the divisions of the scale for each gasometer.

By the aid of this instrument the illuminating power may also be ascertained by making, by the skilful handling of the stop-cock K, the consumption equal to 38 litres, and then measuring the height of the flame; but this process is not so simple, and less convenient for practical purposes.—*Le Gaz.*

* It seems at first sight that the diameter of the hole is an essential element to be considered; but in this apparatus it is not so, since the amount of gas consumed is regulated by the photo-rheometer, independently of the burner employed.

* Each instrument is marked with the number of millimètres which the gasometer should rise, in order that the expenditure of gas should correspond to 38 litres; th s number may vary from 126 to 128 millimètres.

CRYSTALLIZED WOOD AND PAPER.

ACCORDING to Prof. Böttger, the simplest method of giving paper and wood surfaces a crystalline coating is as follows: Mix a very concentrated cold solution of salt with dextrine, and lay the thinnest possible coating of the fluid on the surface to be covered, by means of a broad soft brush. After drying, the surface has a beautiful bright mother-of-pearl coating, which, in consequence of the dextrine, adheres firmly to paper and wood. The coating may be made adhesive to glass by doing it over with an alcoholic shellac solution.

Prof. Böttger mentions the following salts as adapted to produce the most beautiful crystalline coating: sulphate of magnesia, acetate of soda, and sulphate of tin. Paper must first be sized, otherwise it will absorb the fluid and prevent the formation of crystal on its surface. Visiting cards with a mother-of-pearl coating have for some time been in use. Colored glass is well adapted for such a coating, which has a good effect when the light shines through.—*Bayerisches Industrie- und Gewerbe-Blatt.*

GRINDING AND POLISHING.

By Joshua Rose.

No. 2.

The leather wheels already described are covered with emery of grades varying, for ordinary work, from No. 60 to 120, and flour emery. The coarser grades perform considerable cutting duty as well as polishing. The manner of putting the emery, and fastening it, upon the wheel is as follows: The face of the wheel is well supplied with hot glue of the best quality, and some roll the wheel in the emery. The emery does not adhere so well to the leather as it does when the operation is performed as follows: Let the wheel either remain in its place upon the shaft, or else rest it upon a round mandril, so that the wheel can revolve upon the same. Then apply the hot glue to about a foot of the circumference of the wheel, and cover it as quickly as possible with the emery. Then take a piece of board about ⅞ inch thick and 28 inches long, the width being somewhat greater than that of the polishing-wheel, and placing the flat face of the board upon the circumferential surface of the wheel, work it by hand, and under as much pressure as possible, back and forth, so that each end will alternately approach the circumference of the wheel, as illustrated in Fig. 6, the movement

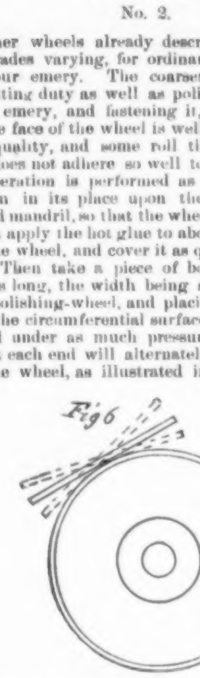


Fig 6

being indicated by the dotted lines. By adopting this method the whole pressure placed upon the board is brought to bear upon a small area of the emery and leather, and the two hold much more firmly together. The speed at which such wheels are used is about 7000 feet per minute. The finest of emery applied upon such wheels is used for cast-iron, wrought-iron, and steel, to give to the work a good ordinary machine finish; but if a high polish or glaze is required, the wheels are coated with flour emery, and the wheel is made into a glaze-wheel by wearing the emery down until it gets glazed, applying occasionally a little grease to the surface of the wheel. Another kind of glaze-wheel is made by covering the wooden wheel with a band of lead instead of a band of leather, and then applying to the lead surface a mixture of rouge, crocus and wax, worn smooth by applying to it a piece of sheet steel or a piece of flint-stone before applying the work. Others add to this composition a little Vienna lime. For flat surfaces, or those requiring to have the corners or edges kept sharp, it is imperative that such wheels as above described—that is to say, those having an unyielding surface—be used; but where such a consideration does not exist, brush and rag wheels may be used. In Europe comparatively large flat surfaces requiring a high polish are finished upon wooden wheels made of soft wood and unemeried, the polishing material employed being Vienna lime. The lime for ordinary use is mixed with water, and is applied by an assistant on the opposite side of the wheel to the operator. For superfine surfaces the Vienna lime is mixed with alcohol, which increases its efficiency; and here it may be as well to note that Vienna lime rapidly deteriorates from exposure to the air, so that it should be kept as little exposed as possible.

BRUSH-WHEELS.

For ordinary work, brush-wheels are excellent appliances, whether employed upon iron, steel, or brass. Their sizes run from 1¼ inch to about 8 inches in diameter, and the hair of the brush should not exceed from one to one and a quarter inch in length. The speed at which they should be run is about 2500 for the largest, and up to 4500 revolutions per minute for the smaller sizes. In ordinary grinding and polishing practice in the United States, brush wheels are used with Vienna lime in all cases in which the lime is used by itself—that is to say, unmixed with wax, crocus, or rouge, or a mixture of the same. In watch-making, however, and for other purposes in which the truth of the work is an important element, Vienna lime is applied to wooden or even metal, such as steel, polishing-wheels, which are in this latter case always of small diameter. An excellent polishing composition is formed of water 1 gill, sperm oil 3 drops, and sufficient Vienna lime to well whiten the mixture. The brush may be let run dry during the final finishing. For polishing articles of intricate shapes, brush wheels are superior to all others. If the articles to be polished are of iron or steel, the first stage of the process is performed with a mixture of oil and emery, Vienna lime being used for final finishing only. The wheels to which Vienna lime is applied should not be used with any other polishing material, and should be kept covered when not in use, so as to keep them free from dust.

For brass-work, brush-wheels are used with crocus, with rouge, or with a mixture of the two, with sufficient water, and sometimes with oil, to cause the material to hold to the brush and not fly off from the centrifugal force. For very fine brass-polishing, the first stages are performed with powdered pumice-stone mixed with sufficient oil to hold it together. This material has considerable cutting qualifications. The next process is with rouge and crocus mixed, and for very fine finishing rottenstone.

RAG-WHEELS.

Rag-wheels are formed of discs of rags, either woollen or strong cotton, placed loosely side by side, and clamped together upon the mandril at the centre only. Their sizes range usually from 4 to 8 inches in diameter, and they are run at a speed of about 7000 feet per minute. They are used for the fine polishing only, and not upon work requiring the surfaces to be kept very flat or the corners very sharp. For use upon steel or iron, they are supplied with a polishing material composed of Vienna lime 3 parts, crocus 3 parts, beeswax 3 parts, boiled up together, allowed to cool off, and then cut into cakes. These cakes are dipped in oil at the end, which is then applied to the rag-wheel occasionally during the polishing process. For brass-work, an excellent polishing composition is composed of crocus 2 parts, wax 1 part, rouge ½ part, the wax being melted, and the ingredients thoroughly mixed. This mixture gives to the metal a rich color. It is dipped in oil and then applied to the rag-wheel. It may be used to polish fine nickel-plating, for which purpose it is an excellent material. Nickel-plated articles having sharp corners should be polished with fine rouge mixed with clear water and a drop of oil, the mixture being applied to the rag-wheel with the finger of the operator. Any of the compositions of rouge, crocus, and rottenstone may be used for brass, copper, or nickel-plated work upon rag-wheels, while for iron or steel work the same materials separate or in combination may be used, though they are greatly improved by the addition of Vienna lime. When, however, either of these materials is used singly, it should be applied to the rag-wheels with a brush; and if it is used dry, it must be at a greatly reduced speed for the wheel, which is sometimes resorted to for very fine polishing.

LEATHER WHEELS.

Another class of wheels much used by brass-finishers is the leather wheel, which is usually made of walrus hide. These wheels are usually made, by brass-finishers themselves, by simply cutting out discs of walrus leather and gluing them together, clamping them between the pieces of board so soon as the glue is applied, so as to make a good joint, and also keep the wheel flat and prevent it from warping during the drying process. Such wheels may be run at a velocity of 8000 feet per minute, and with any of the polishing materials already referred to. After the wheel is made and placed upon its spindle or mandril it may be turned true with ordinary wood-turning tools—and we may here remark that rag wheels may be trued in the same way. The spongy nature of these wheels renders them very efficient for polishing purposes for the following reasons: The polishing materials become imbedded in the leather and are retained, and become mixed and glazed with a fine film of the material being polished, which film possesses the very highest polishing qualifications. These walrus wheels may be used with pumice, crocus, rouge, or Vienna lime, according to the requirements of the case, or even with a mixture of flour emery and oil; and they possess the advantage of being less harsh than leather or lead-covered wheels, while they are more effectual than the latter, and will answer very well for flat surfaces.

CONNECTICUT SAND.

Another polishing material for brass work which is very highly esteemed is Connecticut sand. It is mixed with sufficient oil to just hold it together, and will polish almost as fine as rouge, but operates very much quicker. It is applied principally to walrus wheels, and a wheel once saturated with it will last four or five hours without any application of the sand. When it gets too wet, new sand is added; but this is to be avoided for fine work, since the more it is used the better it gets as a polishing material.

Brass-finishers employ wooden wheels covered with emery of various grades to rough out the work, then a fine cutting material, such as pumice, and finally rouge and crocus, or Connecticut sand, to finish. They also employ emery belts for work of irregular shape. These are leather belts running over two wheels placed some little distance—as, say, from two to four feet—apart, and coat them with emery held on by glue. The work is applied between the wheels where the belt runs horizontally. After the work has been rouged out on the belts it is finished with brush or walrus wheels, as already described.

PROPORTIONS OF NON-CONDENSING HORIZONTAL ENGINES.

The data following are based upon a maximum tensile stress of 12,000 lbs. per square inch of section for wrought iron, and 10,000 lbs. per inch of section for cast iron, and proportionate allowances for other strains and shocks.

Several hundred engines, ranging from 6 to 18 inches diameter of steam cylinder, have been built from designs based upon these data, and have proven good and serviceable, few having broken down, and fewer still having become unduly worn, while to the eye they appear light, and evince great economy of material.

A = Area of piston.
D = Diameter of piston or bore of cylinder.
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Area steam ports = A × .06.
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Diameter piston valves = D ÷ 3.
Length of packing of piston valves = D ÷ 6.
Outside lap = width of steam port

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Diameter = D ÷ 6.
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Length between centres = 3 S = 6 D.
Diameter at necks = D ÷ 6.
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Least area of strap = area of piston rod.
Distance of key way from end of butt = ½ diameter of crank-pin.
Depth of jib and key = diameter piston-rod.
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Taper of key = ¼ inch per foot.
Length of key = breadth of strap × 2.

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Diameter hub = diameter piston-rod × 2.
Length of eye = diameter piston-rod × 2.5.
Taper of eye = 1 in 20.
Section of key = section of piston-rod ÷ 1.5.
Area of slide surface = A ÷ 4.
Length of slide-brass = D × 0.8.
Crosshead-pin: length = D × 0.3; diameter = D × 0.188.
Ratio of length to diameter = 1.5 to 1.

Crank-pin:

Diameter = D × 0.2.
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Diameter large hub = D × 0.9.
Length large hub = D × 0.5.
Diameter small hub = diameter crank-pin × 2.25.
Length small hub = diameter crank-pin × 1.25.

Main-shaft:

Diameter = D × 0.4.
Length of journal (crank end) = D × 0.6.

Plummer blocks:

(d = diameter of journal.)

Thickness of binder = d × 0.4.
Thickness of base = d × 0.3.
Diameter of bolts (if two) = d × 0.25.
Diameter of bolts (if four) = d × 0.18.
Centre of shaft to lower side of base = d × 1.25.
Length of base = d × 3.75.
Thickness of metal of brasses = d × 0.125.

Fly-wheel pulleys:

Diameter = D × 8.
Width of face = D × 1.875.
Mean thickness of rim = D × 0.11.

M. W. Wheeler.

New York, August, 1876.

SHRINKAGE STRAINS IN CASTINGS.

By Mr. Alfred E. Watkins.

Solid Cylinders.—In the case of a shaft, or other solid cylinder, it will be noticed that the surface of the casting at the ends will be slightly depressed. This is occasioned by the surface of the cylinder being cooled by the walls of the mould first, and setting, while the central portion yet remains fluid or soft. In a few moments more the central portion cools, and in shrinking draws in the ends of the cylinder, the outer crust acting as a prop or stay to the atoms of metal adjacent to it. If this theory be correct, the depression should take the form of an inverted cone, owing to the gradual checking of the shrinkage as it approaches the outer crust. In practice this will be found the case, the obtuseness of the angle being greater or less, according to the nature of the iron to shrink.

Globes.—The shrinkage strains within hollow, spherical shell castings are similar to those explained under the head of rings, they being no more in fact than rings continued about a central axis. In the case of solid globular castings the heart or central point within will, usually, be found hollow or porous, owing to the following causes: The walls of the mould cooling off the outer surface, causes it to set immediately; the interior, cooling from the exterior inward, endeavors to shrink away from the outer crust, which resists its so doing; hence, the interior is kept to a greater diameter than is natural, and there being but so much metal in the entire mass, the atoms are drawn away from the central point toward all directions to supply the demand made by the metal in shrinking.

Discs.—In the case of flat round discs or plates they will usually be found hollow on the top side, although in some cases the hollow is on the bottom side. This is owing to the following causes: The top and bottom faces, together with the outside edge, become set first through contact with the mould, leaving the centre yet soft. When the centre shrinks a severe strain is put on the plate by an effort to reduce its diameter, which the outer edge resists. Now, if the cop be thin, the heat will radiate rapidly in that direction, causing the outer or top side to set first; the under side, setting later, will drag the top side over with it, causing it to round up on top and dish in the bottom. Or if the pattern be not perfectly true in every direction the strains first spoken of will cause any curved portion to become more exaggerated. If the pattern be perfectly true, cop and drag of the same thickness, and both rammed evenly, there is no reason why the plate should not come out perfectly true, the strains being all self-contained in the same plane and balanced. If the plate, however, have an ogee moulding projecting downward around the edge it will likely be depressed on the top surface when cast. This is due to all the surfaces being set alike and at the same instant, excepting the metal within the corners, which, containing the most metal in a mass, will shrink last of all. When this does shrink its tendency is to pull over the top side of the moulding toward the plate, which being soft, although set, will be forced downward at the edges, giving a chance for the strains within the plate, as above described, to aid in the distortion.

Round and Square Bars.—These strains are similar in both, and are already treated of under solid cylinders. There is another feature, not before spoken of, which is rather curious. If two bars of the same dimensions and mixture of iron be heated to the same temperature, the one allowed to cool in the mould, the other plunged while hot into water, the latter will be found to have shrunk the most. This is due to the particles about the surface having been enabled, by the softness of the interior metal, to get closer to each other than they could have done if the material had cooled slowly.

Rectangular Tubes.—These are usually cast with a core, which has a tendency to retain the shape of the casting, still the flat sides will show a tendency to bulge up slightly at the middle. This is due to much of the same causes as explained in the plate with the ogee mouldings—the outer surface is cooled instantly by the walls of the mould, and is set; the inner surface is not cooled quite so rapidly, owing to the core being of harder material, and not so good a conductor of heat; when this does cool it will pull inward the outer skin of the casting, forming a slight curve; each side acting for itself will produce the same effects.

Gutter or U-shaped Castings.—These are usually made thinner at the edges than at the middle, because the pattern has been made with draught. When castings of this shape are taken from the mould, they will be found rounded over in the direction of their length, the legs being on the curved side. This is explained by the mould cooling and setting the legs first; then when the back or round shrinks it pulls upward the two ends of the casting.

Wedge-shaped Castings.—In parallel castings of any length, having a cross section similar to a wedge, or similar to a "knife" in paper-mill work, the thick side will invariably be found concave and the thin edge curved. This is due to the same causes as explained above. The thin edge is set as soon as cast, the thick edge, cooling later, shrinks and draws the ends of the casting upward, and with them the thin edge, which acts as a pillar to resist further shrinkage.

Ribs on Plates.—All ribs have a tendency to curve a plate if they be thicker or of the same thickness as the plate, owing to the fact that whatever shrinkage strain they possess is below the general plane of the shrinkage of the plate itself. If the ribs be thinner than the plate they will cool first, and by resisting the shrinkage of the bottom of the plate cause it to curve upwards, or "dish" on top.

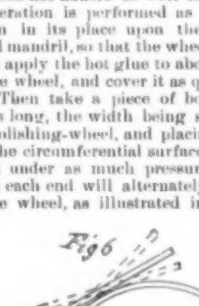
General Laws regarding Shrinkages.—The most metal in a mass always shrinks last, hence, if a casting be composed of irregular thickness it will be liable to be broken by the

GRINDING AND POLISHING.

By Joshua Rose.

No. 2.

The leather wheels already described are covered with emery of grades varying, for ordinary work, from No. 60 to 120, and flour emery. The coarser grades perform considerable cutting duty as well as polishing. The manner of putting the emery, and fastening it, upon the wheel is as follows: The face of the wheel is well supplied with hot glue of the best quality, and some roll the wheel in the emery. The emery does not adhere so well to the leather as it does when the operation is performed as follows: Let the wheel either remain in its place upon the shaft, or else rest it upon a round mandril, so that the wheel can revolve upon the same. Then apply the hot glue to about a foot of the circumference of the wheel, and cover it as quickly as possible with the emery. Then take a piece of board about ¾ inch thick and 28 inches long, the width being somewhat greater than that of the polishing-wheel, and placing the flat face of the board upon the circumferential surface of the wheel, work it by hand, and under as much pressure as possible, back and forth, so that each end will alternately approach the circumference of the wheel, as illustrated in Fig. 6, the movement



being indicated by the dotted lines. By adopting this method the whole pressure placed upon the board is brought to bear upon a small area of the emery and leather, and the two hold much more firmly together. The speed at which such wheels are used is about 7000 feet per minute. The finest of emery applied upon such wheels is used for cast-iron, wrought-iron, and steel, to give to the work a good ordinary machine finish; but if a high polish or glaze is required, the wheels are coated with flour emery, and the wheel is made into a glaze-wheel by wearing the emery down until it gets glazed, applying occasionally a little grease to the surface of the wheel. Another kind of glaze-wheel is made by covering the wooden wheel with a band of lead instead of a band of leather, and then applying to the lead surface a mixture of rouge, crocus and wax, worn smooth by applying to it a piece of sheet steel or a piece of flint-stone before applying the work. Others add to this composition a little Vienna lime. For flat surfaces, or those requiring to have the corners or edges kept sharp, it is imperative that such wheels as above described —that is to say, those having an unyielding surface—be used; but where such a consideration does not exist, brush and rag wheels may be used. In Europe comparatively large flat surfaces requiring a high polish are finished upon wooden wheels made of soft wood and unemeried, the polishing material employed being Vienna lime. The lime for ordinary use is mixed with water, and is applied by an assistant on the opposite side of the wheel to the operator. For superfine surfaces the Vienna lime is mixed with alcohol, which increases its efficiency; and here it may be as well to note that Vienna lime rapidly deteriorates from exposure to the air, so that it should be kept as little exposed as possible.

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For ordinary work, brush-wheels are excellent appliances, whether employed upon iron, steel, or brass. Their sizes run from 1½ inch to about 8 inches in diameter, and the hair of the brush should not exceed from one to one and a quarter inch in length. The speed at which they should be run is about 2500 for the largest, and up to 4500 revolutions per minute for the smaller sizes. In ordinary grinding and polishing practice in the United States, brush wheels are used with Vienna lime in all cases in which the lime is used by itself—that is to say, unmixed with wax, crocus, or rouge, or a mixture of the same. In watch-making, however, and for other purposes in which the truth of the work is an important element, Vienna lime is applied to wooden or even metal, such as steel, polishing-wheels, which are in this latter case always of small diameter. An excellent polishing composition is formed of water 1 gill, sperm oil 3 drops, and sufficient Vienna lime to well whiten the mixture. The brush may be let run dry during the final finishing. For polishing articles of intricate shapes, brush wheels are superior to all others. If the articles to be polished are of iron or steel, the first stage of the process is performed with a mixture of oil and emery, Vienna lime being used for final finishing only. The wheels to which Vienna lime is applied should not be used with any other polishing material, and should be kept covered when not in use, so as to keep them free from dust.

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RAG-WHEELS.

Rag-wheels are formed of discs of rags, either woollen or strong cotton, placed loosely side by side, and clamped together upon the mandril at the centre only. Their sizes range usually from 4 to 8 inches in diameter, and they are run at a speed of about 7000 feet per minute. They are used for the fine polishing only, and not upon work requiring the surfaces to be kept very flat or the corners very sharp. For use upon steel or iron, they are supplied with a polishing material composed of Vienna lime 3 parts, crocus 3 parts, beeswax 3 parts, boiled up together, allowed to cool off, and then cut into cakes. These cakes are dipped in oil at the end, which is then applied to the rag-wheel occasionally during the polishing process. For brass-work, an excellent polishing composition is composed of crocus 2 parts, wax 1 part, rouge ½ part, the wax being melted, and the ingredients thoroughly mixed. This mixture gives to the metal a rich color. It is dipped in oil and then applied to the rag-wheel. It may be used to polish fine nickel-plating, for which purpose it is an excellent material. Nickel-plated articles having sharp corners should be polished with fine rouge mixed with clear water and a drop of oil, the mixture being applied to the rag-wheel with the finger of the operator. Any of the compositions of rouge, crocus, and rottenstone may be used for brass, copper, or nickel-plated work upon rag-wheels, while for iron or steel work the same materials separate or in combination may be used, though they are greatly improved by the addition of Vienna lime. When, however, either of these materials is used singly, it should be applied to the rag-wheels with a brush; and if it is used dry, it must be at a greatly reduced speed for the wheel, which is sometimes resorted to for very fine polishing.

LEATHER WHEELS.

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(d = diameter of journal.)

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Diameter = D × 8.
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M. W. Wheeler.

New York, August, 1876.

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By Mr. Alfred E. Watkins.

Solid Cylinders.—In the case of a shaft, or other solid cylinder, it will be noticed that the surface of the casting at the ends will be slightly depressed. This is occasioned by the surface of the cylinder being cooled by the walls of the mould first, and setting, while the central portion yet remains fluid or soft. In a few moments more the central portion cools, and in shrinking draws in the ends of the cylinder, the outer crust acting as a prop or stay to the atoms of metal adjacent to it. If this theory be correct, the depression should take the form of an inverted cone, owing to the gradual checking of the shrinkage as it approaches the outer crust. In practice this will be found the case, the obtuseness of the angle being greater or less, according to the nature of the iron to shrink.

Globes.—The shrinkage strains within hollow, spherical shell castings are similar to those explained under the head of rings, they being no more in fact than rings continued about a central axis. In the case of solid globular castings the heart or central point within will, usually, be found hollow or porous, owing to the following causes: The walls of the mould cooling off the outer surface, causes it to set immediately; the interior, cooling from the exterior inward, endeavors to shrink away from the outer crust, which resists its so doing; hence, the interior is kept to a greater diameter than is natural, and there being but so much metal in the entire mass, the atoms are drawn away from the central point toward all directions to supply the demand made by the metal in shrinking.

Discs.—In the case of flat round discs or plates they will usually be found hollow on the top side, although in some cases the hollow is on the bottom side. This is owing to the following causes: The top and bottom faces, together with the outside edge, become set first through contact with the mould, leaving the centre yet soft. When the centre shrinks a severe strain is put on the plate by an effort to reduce its diameter, which the outer edge resists. Now, if the cop be thin, the heat will radiate rapidly in that direction, causing the outer or top side to set first; the under side, setting later, will drag the top side over with it, causing it to round up on top and dish in the bottom. Or if the pattern be not perfectly true in every direction the strains first spoken of will cause any curved portion to become more exaggerated. If the pattern be perfectly true, cop and drag of the same thickness, and both rammed evenly, there is no reason why the plate should not come out perfectly true, the strains being all self-contained in the same plane and balanced. If the plate, however, have an ogee moulding projecting downward around the edge it will likely be depressed on the top surface when cast. This is due to all the surfaces being set alike and at the same instant, excepting the metal within the corners, which, containing the most metal in a mass, will shrink last of all. When this does shrink its tendency is to pull over the top side of the moulding toward the plate, which being soft, although set, will be forced downward at the edges, giving a chance for the strains within the plate, as above described, to aid in the distortion.

Round and Square Bars.—These strains are similar in both, and are already treated of under solid cylinders. There is another feature, not before spoken of, which is rather curious. If two bars of the same dimensions and mixture of iron be heated to the same temperature, the one allowed to cool in the mould, the other plunged while hot into water, the latter will be found to have shrunk the most. This is due to the particles about the surface having been enabled, by the softness of the interior metal, to get closer to each other than they could have done if the material had cooled slowly.

Rectangular Tubes.—These are usually cast with a core, which has a tendency to retain the shape of the casting, still the flat sides will show a tendency to bulge up slightly at the middle. This is due to much of the same causes as explained in the plate with the ogee mouldings—the outer surface is cooled instantly by the walls of the mould, and is set; the inner surface is not cooled quite so rapidly, owing to the core being of harder material, and not so good a conductor of heat; when this does cool it will pull inward the outer skin of the casting, forming a slight curve; each side acting for itself will produce the same effects.

Gutter or U-shaped Castings.—These are usually made thinner at the edges than at the middle, because the pattern has been made with draught. When castings of this shape are taken from the mould, they will be found rounded over in the direction of their length, the legs being on the curved side. This is explained by the mould cooling and setting the legs first; then when the back or round shrinks it pulls upward the two ends of the casting.

Wedge-shaped Castings.—In parallel castings of any length, having a cross section similar to a wedge, or similar to a "knife" in paper-mill work, the thick side will invariably be found concave and the thin edge curved. This is due to the same causes as explained above. The thin edge is set as soon as cast, the thick edge, cooling later, shrinks and draws the ends of the casting upward, and with them the thin edge, which acts as a pillar to resist further shrinkage.

Ribs on Plates.—All ribs have a tendency to curve a plate if they be thicker or of the same thickness as the plate, owing to the fact that whatever shrinkage strain they possess is below the general plane of the shrinkage of the plate itself. If the ribs be thinner than the plate they will cool first, and by resisting the shrinkage of the bottom of the plate cause it to curve upwards, or "dish" on top.

General Laws regarding Shrinkages.—The most metal in a mass always shrinks last, hence, if a casting be composed of irregular thickness it will be liable to be broken by the

forces contained within itself. It is, therefore, especially necessary that columns and castings, supporting or resisting great pressures, should be so designed as to prevent this great error. Mouldings on columns are often so badly designed with regard to this matter, that the columns are excessively weak where they should be strongest. As a rule, mouldings should seldom be cast on a column, but rather bolted on. Much of the irregularity of flat castings and those of irregular shapes could be remedied by a proper attention to cooling the castings while in the mould. To be sure this is done to a certain extent, though few moulders know why they do so. They know that by removing the sand from a particular casting it will straighten in the shrinking. This is but the result of experience, not of thought or any attempt to know why they so act. It is useful to know, also, that all shrinkage takes place while the casting is changing from a red to a black heat.

THE HORSE-POWER OF HEAVY GUNS.

In order that a comparison may be instituted between the efficiency of various natures of ordnance it is requisite that the energy of the projectiles discharged should be ascertained. This is an exceedingly simple matter, and the system of calculation employed gives the absolute energy in terms of foot-tons; in other words, when a shot is said to have an energy of 2000 or 20,000 foot-tons, the meaning intended to be conveyed is that as much work has been done on the shot by the powder as would suffice to lift 2000 or 20,000 tons 1 ft. high. This mode of expression is extremely useful and convenient, but it hardly conveys a complete idea of the power actually exerted by a given charge during the process of combustion. It may interest our readers if we push such an investigation a little further, and show what the horse-power of such a gun as that of 80 tons really is. It will be seen that the ordinary expression $\frac{W v^2}{2g}$ takes no account whatever of time; but it is impossible to reduce energy to terms of horse-power without taking time into account. It is very easy, however, to introduce the latter element into calculations concerning the power of guns, and, this being done, we can at once prepare a statement which will show at a glance what the horse-power of a gun is; and, although it may appear at first sight that the term horse power is out of place when used in connection with guns, we think it will be possible to prove that such a phrase may be used with a certain amount of advantage now and then, if not invariably.

As the weight of the charge, and of the projectile, and the diameter of the bore of the 80-ton gun are not yet fixed, it will be unnecessary to deal with precise quantities at present. We shall assume that a projectile, weighing 1400 lbs., and 16 in. diameter, can be fired from the 80-ton gun with 300 lbs. of powder, the muzzle velocity being 1500 ft. per second. These figures are not strictly accurate, the power of the gun being a little greater than this, but they are quite near enough for our present purpose. Allowing for the space occupied by the powder, cartridge, etc., we may assume that the distance from the centre of gravity of the shot to the muzzle of the gun is about 15 ft. The average velocity of the shot in the bore of the gun will be half the muzzle velocity. This last is by the conditions 1500 ft. per second. The time occupied by the shot in traversing the bore of the gun will therefore be the fiftieth part of a second, and its average velocity in the bore of the gun will be 750 ft. per second. If we knew what the average pressure on the base of the shot during the fiftieth part of a second was, we could arrive at once at the horse-power, and no doubt the requisite data will be available by and by. At present, however, nothing is known—at least by us—but the initial pressure, which amounts to from 20 to 25 tons per inch. It is impossible, consequently, to estimate the horse-power of the gun in this way. We must therefore for the present proceed on another system. The muzzle velocity of the shot is 1500 ft. per second, and to acquire this, if no force but the action of gravity were brought into play—in other words, if the shot were allowed to fall freely through space—the descent must extend through a distance of not less than 34,938 ft., or over six and a half miles. For the benefit of our younger readers, we may stop here for a moment to explain that when the final velocity of a falling body is given, the height in feet from which it has fallen can be ascertained by dividing the square of the velocity by 64.4, or, for all ordinary purposes, by 64 only. Expressed algebraically, the rule becomes $\frac{V^2}{2g} = H$. If, therefore, the muzzle of the 80-ton gun were directed vertically upwards, a 1400-lb. projectile would be carried to a height of 34,938 ft. provided the air offered no resistance. We may, in the present instance, neglect the influence of the air, because it in no way affects the work done *on* the shot, although it would affect the useful work done *by* the shot in practice. The initial velocity of the shot was, as we have seen, 1500 ft. per second, but this speed begins to decrease from the moment the shot leaves the muzzle of the gun until it ceases altogether at a point 34,938 ft. above the muzzle. The average velocity of the shot during its flight will be 750 ft. per second, and the whole time of flight will be in round numbers 47 seconds. Now, the energy stored up in the projectile is by the formula $\frac{1400 \times 1500^2}{64.4}$ = 48,913,200 foot-pounds. If we divide this by 47, and multiply the quotient by 60, we find that the foot-pounds per minute amount to 62,442,360. This is equivalent to not less than 1892 horse-power. We may, taking into consideration the fact that we have slightly underrated the capabilities of the weapon, call the 80-ton gun 2000 horse-power. It is quite true that the gun does not work continuously for a minute or an hour. If the effort which is extended over the fiftieth part of a second only were continued over a minute or an hour, it is obvious that the power of the gun would have to be represented by something enormously greater than 2000 horse-power. In the shot, however, we have a duration of motion which is not limited to a small fraction of a second; it extends over several seconds, and, if the gun were fired in the way indicated, it is obvious that the projectile would possess energy enough to exert 2000 horse-power for over three quarters of a minute.

Such calculations as the foregoing may be regarded, of course, as possessing no practical value. But if we take into consideration the number of rounds that can be fired per hour, and multiply these by the energy expended in each round, reduced to terms of foot-pounds per second, it will be seen that we can as justly calculate the horse-power of a gun as that of a Cornish engine. Each round fired may be taken as the equivalent of one stroke. Now, small guns can be fired as fast as a slow-running Cornish engine; and it is clear that if the work done by a Cornish engine, even though it made only a stroke a minute, may be estimated in terms of horse-powers, we may with as much propriety apply the terms to guns firing sixty or any smaller number of rounds per hour. The power of an engine will—other things being equal—vary as the number of strokes per minute, and the power of guns will vary in the same way for similar reasons. If, then, we calculate the efficiency of guns in terms of horse-power, we shall have a very ready and accurate means of comparing the value of two guns constructed on different systems, but of the same size. Thus, if a gun of a given size, say 40 lbs., can be fired twice as fast as another gun of the same size but of a different pattern—other things being equal the former gun is twice as powerful as the latter. Of course, many other things must be taken into consideration besides rapidity of fire, and a large gun firing a round every two minutes will be for certain purposes much better than a smaller gun firing at three times the rate. The comparison, therefore, must be confined to guns of a size, and with this limitation it may be found useful. Whether this is or is not the case, we venture to think that those who have followed us to this point will be in a better position to realize the true powers of the mighty engines of war that we now use, than would have been the case had they continued to deal only with energy expressed in terms of foot-pounds so enormous that the mind fails to attach any definite idea to the figures.—*The Engineer.*

SHIPS OF THE BRITISH NAVY.

There are 348 ships on the list. Of these 315 are screw ships, 23 paddle, and 10 sailing.

Of the 315 screw vessels now in commission, the return shows that 26 are armor-plated, comprising 18 broadside ships, 4 turret ships, 3 corvettes, and 1 floating battery. The armor-plated ships in reserve, or appropriated to harbor service, are 30 in number (including the Vanguard), and consist of 13 broadside ships, 10 turret ships, 1 ram, 1 sloop, 3 gunboats, and 2 floating batteries. Irrespective of the armor-plated ships, there are 9 line-of-battle ships in commission and 21 in reserve. There are also in commission 9 frigates, 16 corvettes, 19 sloops, 31 gun vessels, and 34 gun-boats, with other craft. In the reserve there are 9 frigates, 13 corvettes, 14 sloops, 12 gun vessels, and 42 gun-boats. It will be observed that these figures only refer to the vessels added since January 1st, 1855. Concerning the iron-clads added during this period (omitting the floating batteries) it is satisfactory to find that with the exception of the Captain and the Vanguard all are in existence, and even the latter is not considered "lost." In respect to the quality of endurance the iron-built armored ships render a good account of themselves. But the wood-built iron-clads are subject to rapid wear. Still, there is no doubt that the cost of keeping the iron-built ships in repair is heavy, though they are capable of being repaired effectively.

On March 31st there were five armored ships building, namely, the Temeraire, Inflexible, Nelson, Northampton, and Ajax. All these are being built of iron, and two—the Inflexible and Ajax—are turret ships. In addition, the Agamemnon, an iron armor-plated turret ship, was about to be commenced when the return was made. The unarmored ships building were twenty-one in number. These consisted of the Euryalus and the Bacchante, iron corvettes sheathed with wood, each of 3932 tons displacement; the Iris and the Mercury, armed dispatch vessels of 3693 tons; the Emerald, Garnet, Turquoise, and Ruby, composite corvettes of 1864 tons; the Cormorant, Osprey, Pelican, Flamingo, Condor, Griffin, and Falcon, composite sloops, the first three with a displacement of 1124 tons, the others having 774 tons; and six iron gun-boats of 386 tons, to be completed by the contractors in September next, the names of the vessels being the Medina, Medway, Sabrina, Spey, Tay, and Tees. Ten unarmored vessels are about to be commenced. Six of these were composite gun-boats, of 420 tons displacement, four to be completed by the contractors this year, and the remaining two early next year. The remainder of the ten are classed as gun-boats of 254 tons displacement. The order for their construction is rather old, it having been suspended in July, 1872, and the return says nothing as to the probable date of their completion.

The return shows something as to the difference in the cost of first-class ships of war in the present period and at a former time. The line-of-battle ships in 1854 cost from £112,000 to £156,000 each for hull and machinery. In like manner the frigates range in price from £53,000 to £95,000. In 1863 we have the Minotaur costing £456,850, and the Achilles nearly as much. In 1866 we have the Northumberland costing £471,000. In 1868 the Hercules cost £361,000, the Monarch, £335,000, and the Inconstant (a frigate) £213,000. In 1870 the Sultan cost £357,000. In 1871 the Devastation figures at £354,000. The price of the Thunderer is likely to be a little less than £300,000. In 1873 the Shah appears at a cost of £230,000, and the Raleigh at £193,000, both being frigates. Last year the Dreadnought was launched, costing £508,000. The price of the Alexandra is still higher, being £522,000. The Vanguard, which was launched in 1870, and lost in 1875, appears to have cost £263,000.

RAILWAY RESISTANCES.

In their recent Report to the Institute of Mining Engineers, the Committee, Messrs. Wm. P. Shiner and P. H. Dudley, give the following results:—

Engine 485 of the Lake Shore and Michigan Southern Railway, developed to move the train, for each pound of coal consumed, 296,545 foot-lbs. of power, or less than 3 per cent of the theoretical power of the coal. To start the train, weight 709 tons, and get it under full motion, it took from 20,000,000 to 40,000,000 foot-lbs., depending upon the place and circumstances. In one place it was 35,696,050 foot-lbs.; dividing this by 296,545, the power developed by 1 lb. of coal, and it gives 120.4 as number of pounds of coal consumed after the stopping of the train to again get it into motion. Take into further consideration the loss of time, and delays to business, and it will be seen that stops are expensive; therefore the time-table should be so arranged, as far as practicable, so that through trains should only stop for water and at terminal division stations and railway crossings. In through lines more attention should be given to the avoidance of grade crossings, not only as a safety measure, but one of economy. In a short time we fully believe that it will be found cheaper in great trunk lines to arrange the freight engines so that they will take water while in motion, or by condensing a portion of the exhaust steam, so as to require but a small part of the water now used. On the Cleveland and Pittsburgh Railway (in an ore train run), from Cleveland to Wellsville, 1 lb. of coal developed 398,763 foot-lbs. to move the train, utilizing in moving the train about 4½ per cent of the theoretical power of the coal, showing a great gain over that developed on the Lake Shore and Michigan Southern Railway. We consider the values of the different engines given by these experiments of the greatest value in determining those which are the most economical for freight purposes. It affords a comparison as to the value of the number and different-sized drivers used on the engines; by taking the amount of coal used, and knowing its general characteristics, we are able to judge of the engine in an economical point of view. To show how erroneous it is to compare the work performed upon one road with that of another by the tonnage moved in miles by one lb. of coal, we will state one example of comparison of the Cleveland and Pittsburgh Railway and the Lake Shore and Michigan Southern Railway. The run upon the Cleveland and Pittsburgh Railway was made with an ore train, from Cleveland to Wellsville, upon which are many long 40-feet grades to reach the table-lands of the country through which it passes. On the table lands there are many short 40-feet grades, also sharp curves. The track was iron, joints very much depressed. On the Lake Shore and Michigan Southern Railway the run was a stock train, steel track, and in good condition, the line mostly tangent, the grades not exceeding 17 feet per mile. The average friction per ton of the train on the Cleveland and Pittsburgh Railway was 10.72 lbs., and on the Lake Shore and Michigan Southern Railway 6.85 lbs., the former some 57 per cent greater than the latter. When we compared the tonnage moved per mile per lb. of coal, they were almost identical; leading one to conclude perhaps that the motive power of one road was operated as economically as the other, whereas in fact, as above stated, the work done upon the Cleveland and Pittsburgh Railway per lb. of coal was 50 per cent greater than upon the Lake Shore and Michigan Southern Railway. The fine effect of steel track in this case is offset by the better adaptation of the motive power upon the other, so that each road would be improved by simply adapting the better principles of the other. It does not afford any accurate test of the economical movement of freight of two roads by a comparison of the tonnage moved in miles per pound of coal, any more than it does of a road to compare the cost of operating to the total receipts. In running trains there are many things which the careful and considerate engineer must do to pull his train over the road to the best advantage for his company's interest, which if rigidly interpreted would be a disobedience of orders. The reason for this is largely owing to the manner of making up the time tables, in not allowing sufficient time in difficult places, and too much where it is comparatively easy. It seems to us more attention should be made to the development within certain kinds of a more uniform development of power. This idea is new, but is very forcibly brought out by a study of the diagrams. In ascending a grade you very soon come to a limit in the power which the engineer can develop, on a given strain. In many instances we have found that upon a grade the engine could not draw the load it had without backing up and acquiring a little momentum to assist it in passing the difficult place. The judicious engineer, instead of running so slowly over such places, takes advantage, and stores up a little momentum in the train to help in a difficult place. We do not approve of any reckless running, but the engineer should be allowed to take advantage of those little things which oftentimes determine whether he can get over a grade or not. Having ridden several thousands of miles upon heavy freight trains, we must say that we do not believe it possible to make a uniform time table on our undulating road, productive of the greatest economy.

In a general statement, we give the average friction per ton of 29 loaded and 2 empty cars from Toledo to Cleveland, total weight of 590 tons, at 20 miles per hour, at 1.45 lb. From Cleveland to Erie, of 37 loaded cars, weight 109 tons, speed 20 miles per hour, 6.85 lbs., and from Erie to Buffalo, of 25 loaded and 2 empty cars, weight 512.4 tons, the friction was 7.94 lbs. per ton. These were upon the Lake Shore and Michigan Southern Railway, and include all the resistance due to gravity and air. On the Cleveland and Pittsburgh Railway from Cleveland to Wellsville the average friction per ton was for an oil train of 313 tons 10.72 lbs. per ton.

Although stated in the previous paper, we will repeat that with the same engine upon the Lake Shore and Michigan Southern Railway to run a train at 10 to 12 miles per hour from Cleveland to Erie, it required 1680 lbs. more of coal than it did with the same number of cars at 18 miles per hour. Weight of train about 100 tons. Upon further investigation of this question, we have found that the drivers are generally worn more unevenly upon slow running locomotives than fast ones.

We also find the statement that it requires less fuel to run trains at 18 miles per hour than at 12 is corroborated by many leading railway men. The American Society of Civil Engineers has appointed a Committee upon this subject, which will co-operate with your Committee.

PNEUMATIC TUBES IN NEW YORK CITY.

The Western Union Telegraph Co. have just put into operation in New York a new system of sending local messages by pneumatic tubes. There are now four tubes in operation—two running to No. 14 Broad Street, one to the Cotton Exchange, and one to 134 Pearl Street. These tubes (made by F. G. Underhay of London under the patents of S. W. Wilmott) are eight inches in circumference and two and a quarter inches in diameter, with a capacity for sending four boxes a minute. The pipes, which are eighteen feet long, and joined by air-tight screw-joints, are laid three feet under ground. The curves have a radius of twelve feet. The engine in use is a thirty horse-power compressing engine, and exhausting at the same time from two separate reservoirs. It has a capacity for forty tubes, although at present there are only four in use. It is intended to extend these pneumatic tubes from all of the principal substations in the city to the main office, thereby materially lessening the cost of transmitting messages, as the services of the despatching and receiving operators are thereby dispensed with. This will also be the case in sending messages to distant points, as by means of the pneumatic tubes the original message will be sent direct to the main office, and thence wired direct to its destination. This differs from the French, English and German systems, by which regular pneumatic trains are started out every half hour, stopping at stated points and returning to the main office. The engine now in use is situated in the basement of the Western Union Building, and is connected with the despatching and receiving tubes by sheet-iron pipes, nine inches in diameter. At a recent trial, messages were transmitted from the Western Union Building to No. 14 Broad Street in 36 seconds, and it is expected that this time will be lessened considerably as soon as the oil and rust are rubbed off from the inside of the tubes.

IMPROVED ADDING PENCIL.

IN our issue of October 21, 1875, we published an illustration and description of a then recently patented adding pencil, the device of Messrs. Smith & Potts, of Verdi, Nevada. Our readers may remember that not long afterwards we printed a paragraph containing a request from the above-named inventors that the public would withhold further letters, as so great was the interest excited by the very ingenious little device that the proprietors found themselves entirely unable to attend to the innumerable requests for further information and orders which poured in upon them. Nearly 5000 pencils, we are told, have been sold, and the sale may be traced to that publication—a significant evidence not only of the value of the device but of the advantages of the SCIENTIFIC AMERICAN as a means of placing an invention before the people.

Very recently the inventors have hit upon a plan of simplifying the device, which practically amounts to a remodelling of the entire mechanism. This we illustrate herewith. By referring to the article relative to the earlier invention, the general capabilities will be found in detail. The device in brief is a miniature calculating machine, which does its work with unfailing accuracy, and without requiring any thought on the part of the operator other than that involved in turning a disk to make coincidence between a figure and a letter. In shape the apparatus resembles a pencil, and its full size is shown in our engraving. It consists of a cylindrical case, closed above, and to the lower end of which is attached a circular flange, the upper side of which is numbered. Inside the hollow cylinder or case is a solid spirally-grooved cylinder, and this carries at its lower end a milled disk which extends outside the flange, and is marked by a series of letters. The lower extremity of the pencil is merely used for pointing. The disposition of flange and disk will be more clearly understood from Fig. 2. In the groove of the solid cylinder, which is numbered, is an index or traveller which projects through the longitudinal slot of the outer case.

Fig. 1

Fig. 2

IMPROVED ADDING PENCIL.

Supposing the various parts to be disposed as in Fig. 1, the method of manipulation is as follows: The index, by rotating the inner cylinder, may be caused to travel up or down the slot; as shown, it stands at 30. To add, for example, 5, that number is first sought on the flange, and coinciding with it on the disk appears the letter F. The disk is then turned by the thumb and finger until said letter F is brought to coincide with the zero mark. This, of course, at the same time rotates the solid inner cylinder so that a distance measured on the groove between the parts marked 30 and 35 travels beneath the index. The latter therefore ascends in the slot, and when the movement is finished remains pointing at 35.

To add another number, the next in a long column for instance, the letter which happens to correspond thereto is as before carried around to zero, and this is continued until the column is finished, when the sum is shown by the index.

The advantage of the present over the older device is that the spring, rack, and cog-wheel mechanism is abolished, rendering the pencil much cheaper, less complicated, and more reliable. It can be used about as fast as a good accountant can cast up a column of figures mentally; but time is saved from the fact that the first footing is always correct, and hence no second or check process is needed. The pencil can be used after very little practice. Interruption during the computation is no annoyance; and indeed the motion may proceed almost mechanically while the operator is engaged in conversation; or he may stop work in the middle of a column, attend to other matters, and resume it after any period of time.

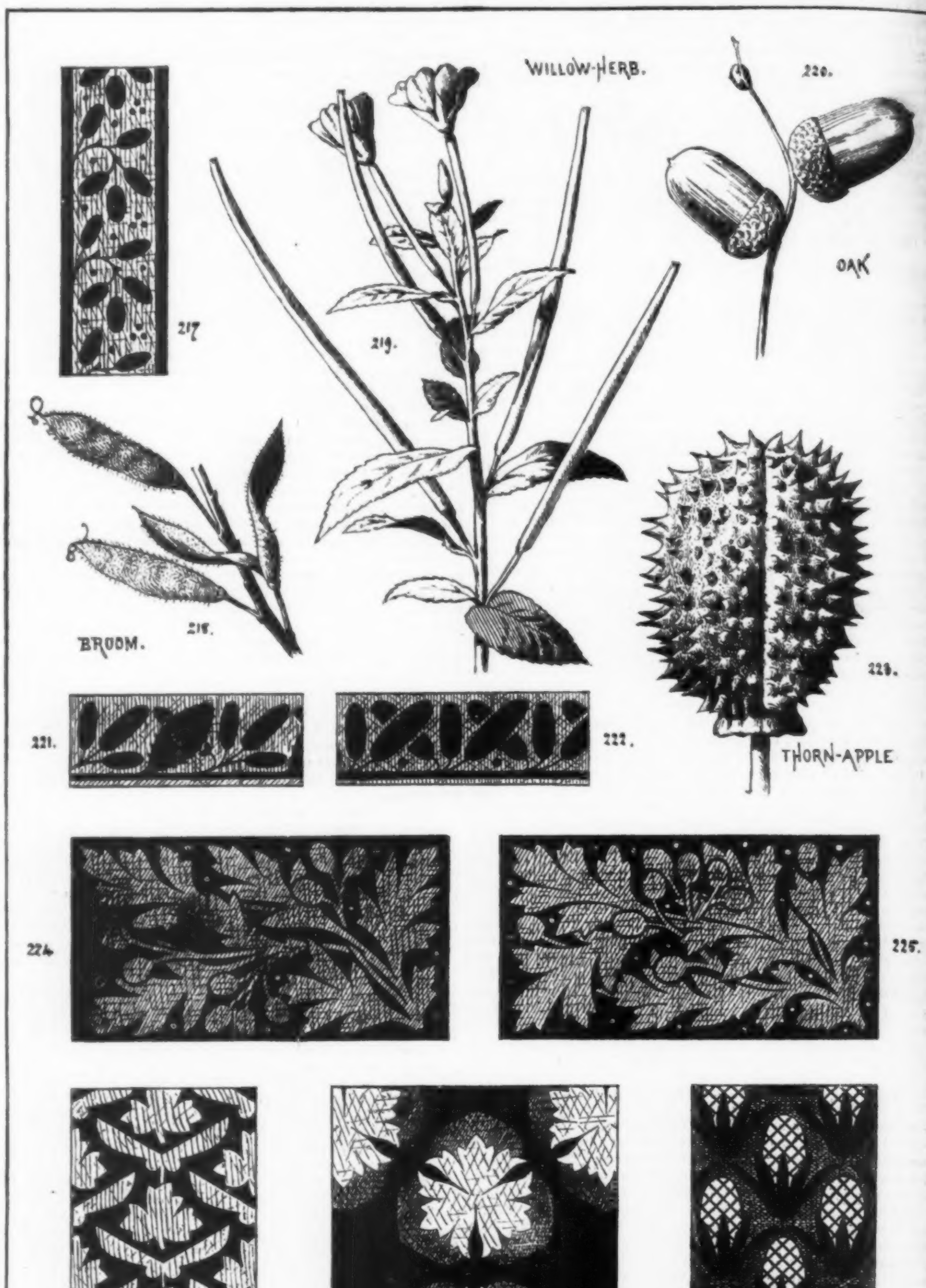
Patented through the Scientific American Patent Agency, April 4, 1876. Patents on improvements pending. The price of the pencil is $5, mailed free. For further information address the Adding Pencil Company, Kirksville, Mo.—*From the Scientific American of August 5th*, 1876.

PRIZES FOR TREE-PLANTING.

THE Trustees of the Massachusetts Society for Promoting Agriculture, having some trust-funds at disposal, have reprinted Prof. Sargent's pamphlet for gratuitous distribution, adding particular directions for the planting and management of seedling trees, and offering very handsome prizes for special plantations within the State of Massachusetts. This board offers, in the first place, for the best plantation of not less than five acres of larch, or on the cape, etc., of Scotch or Corsican pine, originally of not less than 2700 trees to the acre, on poor, worn-out or otherwise agriculturally worthless land, a prize of $1000. For the next best, a prize of $600; for the third best, $400. Next, for the best plantation of the same extent with American white ash, not less than 5000 trees to the acre, a prize of $600; for the next best, $400. Intending competitors must notify the Secretary of the Society, E. N. Perkins, Jamaica Plain, Boston, as early as December 1, 1876, and plant in the spring of 1877. Special directions, not only for planting and caring for, but also for procuring trees for the purpose, are given in the pamphlet, and a citizen of Boston patriotically offers to look after the importation of the seedling trees, which in such quantities and for next year's planting would have to be obtained mainly in Europe, at least the pines and larches. The ashes, probably would have to be raised from seed; and the time, if need be, would doubtless be extended. The prizes to be awarded in the summer of 1877. Mr. Sargent's estimates promise a handsome return for the capital and labor invested in judicious tree-planting for economical purpose; these timely prizes may stimulate enterprise; and the sense of contributing to the adornment as well as to the material resources of the country should also be a motive and a reward.

SUGGESTIONS IN FLORAL DESIGN.

THE acorns of the common oak (Fig. 220) and the pods of the yellow broom (Fig. 218) are sufficiently well known to need no comment; the seed-vessels of the willow-herb (Fig. 219) are perhaps scarcely so familiar as the former, though for ornamental purposes, and more especially for the decoration of fabrics requiring a light and delicate treatment, they seem excellently well adapted. Fig. 223 is the very striking-looking fruit of the thorn apple, one of our less common wild plants. The suggestions based on various fruit forms owe to the following plants their origin: Figs. 217, 221, and 222 are all treatments of the barberry; Figs. 224 and 225 are derived from the hawthorn; Fig. 226, from the maple; Fig. 227, from the common nut; and 228 from the fir-cone. The designer is exposed to a choice of evils, for while in the town he is unable to make that close study, and to enjoy that daily fellowship with nature that is so desirable; he is, on the other hand, if a dweller in the country, to some extent shut out of the busy world, and the opportunities of turning his knowledge to practical account. It is, however, beyond doubt that a study of nature is of great importance, and even the townsman may from time to time snatch an afternoon and gather new life and energy both for himself and his work amidst the hedge-rows. As an illustration of what may thus be gathered, we had the curiosity to note down the names of all the plants actually in flower that we were able to find by the sides of the high road in the country during half an hour. Though there had long been a time of excessive drought, and almost every thing appeared to be burnt up, the experiment being made at the end of July, 1874, we found no less than forty-eight plants in full flower in the space of one mile, in thirty minutes, and without leaving the dusty highway. Without giving a formal catalogue, we may mention that this list included such valuable plants for the purposes of the designer as the silverweed, cinquefoil, bramble, bush-vetch, yellow bedstraw, rest harrow, small bindweed, germander speedwell, bird's-foot trefoil, meadow crane's-bill, celandine, honeysuckle, centaurea, scabious, vervein, and meadow vetchling, the whole being within two miles of a railway station.—F. EDWARD HULME, F.L.S., F.S.A.—*The Building News.*



SUGGESTIONS IN FLORAL DESIGN.—BY F. E. HULME, F.S.A.

BLEACHING WOOL.—A wooden tank is filled with a solution of bisulphite of soda, containing five parts of this salt to 100 of water. Muriatic acid is then added to the extent of 3 parts to 100 of the bisulphite used, and the wool or woollen goods are steeped in the liquid.